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LORD LINDSAY, M.P., F.R.S., President, in the Chair.

Maures Horner, Esq., 15 Bishopsgate Street Within, E.C.;
E. E. Markwick, Esq., East Acton, Middlesex;
Arthur E. Nevins, Esq., 3 Abercrombie Square, Liverpool; and
Charles Clement Walker, Esq., Lilleshall Old Hall, Newport, Shropshire;

were balloted for, and duly elected Fellows of the Society.

Observations of Encke's Comet, 1878.

By J. Tebbutt, Esq.

The positions of Encke's Comet which I now send were determined by me with a ring-micrometer on the $4\frac{1}{2}$-inch Equatoreal. I found it very difficult to observe the comet owing to the absence of a nucleus or other well defined condensation. All I could do was to note the bisection of the comet at the edges of the ring. The larger telescopes of the southern hemisphere will doubtless furnish more accurate places. The comet was first seen by me on the 3rd August, and observed till the 28th; but as it was excessively faint after the 17th, I do not think the positions subsequent to that date will be of any real value. With some few exceptions, in which the correction could not amount to a second of arc, the differential observations have been corrected for refraction, but in every case the proper motion corrections have been applied. The star places derived from the Catalogues of Lalande and Weisse have been brought up to the mean epochs 1839 and 1852 respectively by means of the precessions in the Catalogues, and the precessions recalculated from Professor Peter's constants. By means of these precessions the mean places have been brought up from 1800 and 1825 to the beginning of 1878. In computing the parallax corrections, the log distances from the Earth have been taken from Dr. von Asten's Ephemeris in No. 2197 of the *Astronomische Nachrichten*, and the mean equatoreal horizontal parallax of the Sun has been

adopted 8″·85. In turning the observations to account, it will be advisable to add 7 seconds of time to the longitude hitherto assumed for my Observatory; the longitude will therefore be $10^h\ 3^m\ 23^s$ E.

It appears that during the period embraced by the observations the comet was about 17 seconds of time east, and 3 minutes of arc south of the positions assigned to it in the Ephemeris of Dr. von Asten.

Observatory, Windsor, N.S. Wales,
November 16, 1878.

Apparent Places of Encke's Comet. 1878.

Date August.	Windsor Mean Time. h m s	Comet's App. R.A. h m s	Correction for Parallax. s +	Comet's App. N.P.D. ° ′ ″	Correction for Parallax. ″ +	No. of Comps.	
5	6 29 45	10 16 14·22	0·42	83 42 31·5	4·4	4	1
6	6 50 9	10 23 59·00	0·43	84 52 29·1	4·4	4	2
7	6 46 12	10 31 32·85	0·43	86 1 17·5	4·4	1	3
8	6 38 55	10 39 3·07	0·43	87 8 51·1	4·5	4	4
9	6 45 39	10 46 36·41	0·44	88 17 48·1	4·5	6	5
10	6 41 9	10 54 2·74	0·44	89 25 31·2	4·5	5	6
11	6 42 42	11 1 28·99	0·44	90 33 26·0	4·5	2	7
12	7 7 50	11 9 3·91	0·45	... ...	...	2	8
13	7 3 15	11 16 28·31	0·46	92 49 12·7	4·5	2	9
14	6 56 4	11 23 49·61	0·45	93 54 36·1	4·5	7	10
15	6 56 11	11 31 13·87	0·46	95 0 26·4	4·5	7	11
16	6 51 4	11 38 36·71	0·45	96 5 51·2	4·4	3	12
17	6 59 0	11 46 2·37	0·46	97 10 8·6	4·4	10	13

Mean Places of the Stars of Comparison for 1878·0 *and Apparent Places for the Dates of Observation.*

Star of Comp.	Mean R.A. h m s	App. R.A. s	Mean N.P.D. ° ′ ″	App. N.P.D. ″	Authority for Star's Mean Place.
1	10 16 55·65	57·20	83 41 9·6	17·9	Lalande. No. 20142.
2	10 25 58·38	59·93	84 43 45·1	52·1	Radcliffe Obs. 1872 & 1874.
3	10 37 47·81	49·37	86 8 7·7	15·5	Lalande. No. 20708.
4	10 37 10·00	11·51	87 11 48·0	55·9	Lalande. No. 20697.
5	10 45 57·63	59·18	88 19 40·3	48·7	Wash. Cat. 1845–71. No. 4533.
6	10 56 18·35	19·92	89 26 15·5	24·6	Lalande. Nos. 21183 & 4.
7	11 6 0·38	1·96	90 30 49·8	59·5	Lalande. No. 21429.
8	11 9 34·86	36·44	... ...	...	Weisse XI. No. 127.
9	11 9 58·22	59·78	... ...	...	Lalande. Nos. 21525 & 6.
9	... ...	...	92 48 26·3	36·5	Wash. Cat. 1845–71. No. 4709.
10	11 23 1·28	2·87	93 46 30·8	41·7	Weisse XI. No. 377.
11	11 28 9·14	10·73	94 51 13·3	24·6	Wash. Cat. 1845–71. No. 4829.
12	11 43 1·75	3·37	96 13 4·3	16·3	Weisse XI. No. 726.
13	11 44 57·02	58·64	97 18 43·9	56·3	Wash. Cat. 1845–71. No. 4961.

Remarks on Mr. Sadler's Paper in the January Number of the Monthly Notices. By C. G. Talmage, Esq.

The January (1879) Number of the *Monthly Notices* contains a paper with the title "Notes on the late Admiral Smyth's *Cycle of Celestial Objects*, volume the second, commonly known as the *Bedford Catalogue*."

It is to be remembered that the book commented on is by a past President and Medalist of the Royal Astronomical Society.

The writer of the article commences by saying that, "unless he is mistaken, the Presidential Address is couched in eminently cautious language as to the exactness of Admiral Smyth's work."

As a matter of fact, he *is* mistaken, for in fairness he should have given these words of the Astronomer Royal: "My confidence in the exactness of the observations is purely personal. Knowing the attention which has been given to the instrumental adjustments, the intentness of the observer upon his work, the nerve, which is made steady rather than disturbed by the anxiety to procure a good observation, and the general skill in the management of the instruments, I can truly say that, if an accurate observation were required, I should desire that it should be made by Captain Smyth. . . . . And in presenting the medal, I beg leave to convey with it the expression that never was a medal more worthily earned."

There is not much ambiguity in language like that; and the Astronomer Royal, in a letter to me lately, again says: "I had great confidence in Captain Smyth's observations."

I have received from Professor C. P. Smyth a letter which he has requested me to read to the meeting. It is in part as follows:—

"I am too busy to be able to come to the meeting, and I should probably be esteemed, if present, an insufficiently disinterested speaker. But at this distance I trust I can look on calmly enough at the affair, and certainly should know some useful and necessary data towards understanding it.

"The case begins with the printing and publishing, by the Royal Astronomical Society, of a paper containing, at first sight, merely a list of errata in my late father's old and now long since out-of-print book, *A Cycle of Celestial Objects*.

"If such a list of errata were ably, thoroughly, carefully made, and deduced by its author from his own recent observations of the heavens, it would add much to the value of the book so corrected, would conduce to the progress of sidereal astronomy, and would prove the ability as well as the experience of the compiler also. Nor need there be any difficulty in accepting that, in such a work as the *Cycle*, new and original in its own day, unique in character and comprehensiveness still, and aiming at describing, sometimes with exactitude, sometimes in a brief cursory manner only, nearly half the heavens, there was an

immense deal left to other men in subsequent ages, with more time at their disposal and larger telescopes, both to improve, perfect, and extend; while to have attempted merely to observe *all* the objects as fully as some of them were, during the comparatively short time the *Cycle* was in preparation, by one man in his private house, would have occupied centuries. And this necessary difference of degree of attention which my father had paid to the very different stellar objects all included together in the *Cycle*, was both abundantly explained by him and understood and appreciated by his contemporaries. So that some of them would take up the book to fish out therefrom a mere approximate note of some star-group to begin their own observations upon; while others would sit down either to study in it the long series of micrometer measures which he had made, year after year, on such an absorbing object as γ *Virginis* or to discuss his orbital representations of its movements both in the past and for the future.

"But in place of any such common-sense and simple-honesty style of criticising a special book as this, and which book no one, particularly observers, need attend to if they can get better information elsewhere, it is most astounding to find that the author of the paper just printed by the Royal Astronomical Society has made few or no observations himself, and has no pretence of being able to produce or having produced a book equally comprehensive and much more exact than the *Cycle*. He has merely collected, at the hands of two or three other persons, after the world has progressed for half a century, after the author of the *Cycle* is dead and his book no longer to be purchased, and when many new professionally appointed men are established in public Observatories in various countries, furnished with telescopes of nine times the power of that which belonged to the private author of the *Cycle*, and have brought them to bear, with plenty of time, leisure, and experience, on a few only of his less important entries, with the certain result of finding some of the old numbers improvable; the writer of the paper taken up by the Royal Astronomical Society has, I say, merely collected a very few corrections of such very correctible and weak items, and then endeavours . . . to ignore the very existence of all the completer, better, more numerous observations in the *Cycle*, and to persist in insinuating that everything whatever in that book must be of the character of the few cited errata, but which he tries to imply are of some very bad origination."

The sentiments expressed in this letter will, I am sure, recommend themselves to every honest man.

Mr. Barclay's Observatory,
Leyton, 1879. *March* 13.

On the practical Advantages of Hartnup's Method of testing Chronometers. By Arthur E. Nevins, Esq.

The difficulties attending the observation of lunar distances at sea and the errors to which the computation of Greenwich time therefrom is liable are well known to be so numerous that this method is hardly ever now practically used by officers in the merchant service, and therefore it becomes a very important matter to have all the reliable information which can be obtained about the performance of marine chronometers, as they are almost exclusively relied upon for ascertaining the longitude at sea.

Having had an experience in the management of chronometers at sea extending over several voyages, and having during that time found that the method of testing chronometers adopted by Mr. Hartnup at the Liverpool Observatory is exceedingly useful, both in selecting a chronometer for purchase and also in carrying on the time by it afterwards, I trust that some account of this experience may be useful to others.

Account of the performance of a Marine Chronometer from the time it left the maker's hands for a period of four years.

In 1874 I selected from the chronometers at Mr. Hartnup's Observatory the chronometer "George Timewell," 1656. This, like most new chronometers, was greatly gaining in its rate, my first three voyages exhibiting respectively $0^s{\cdot}9$, $0^s{\cdot}4$, and $0^s{\cdot}2$ per day of acceleration.

After these voyages the instrument was tested in March, April, and May 1877, at the Liverpool, Observatory, preparatory to a voyage to Australia and India. The following Table shows the results obtained from this test:—

1877.	Mean Daily Rates.	Mean Temperature Fahrenheit.
	s	°
March 10–17	−0·95	85
17–24	−0·05	70
24–31	−0·60	55
31–April 7	+0·65	70
April 7–14	−0·12	85
14–21	+0·33	70
21–28	−0·17	55
28–May 5	+0·78	70
May 5–12	+0·15	85
12–19	+0·80	70

The values of C and T we found to be—

$$C = -0{\cdot}0037 \qquad T = 70{\cdot}03^s.$$

It will be seen from the Table of Observatory Rates given above that this watch was still gaining a little on its rate, and therefore R was assumed to be $+0^{s}\cdot80$, which was the rate kept during the last two weeks in which it was exposed to a temperature of 70° F., instead of $+0^{s}\cdot50$, which was its value as deduced from the whole test.

A table of rates for each degree of temperature from 40° to 90° F. was then calculated, the values of C and T being taken as obtained from the whole test by the above calculation, and the value of R being taken at $+0^{s}\cdot80$.

The formula used for these calculations is

$$\text{Rate in any given temperature} = R-(N^2 \times C),$$

where N is the difference of the temperature in question from T, reckoned in degrees Fahrenheit.

Throughout the voyage the rates were taken from this Table day by day according to the mean temperature of the previous twenty-four hours, and the results obtained during a fifteen months' voyage are given in the following Table:—

Date.	Errors of No. 1656 on G.M.T.		Differences.	Nature of Observations for Time.
	By Calculation.	By Observation.		
1877.	m s	m s	m s	
June 20	+1 29·0	+1 29·0	0 00·0	Left London.
Sept. 24	+2 10·5	+2 16·2	0 5·7	Melbourne time ball.
Nov. 15	+2 35·2	+3 8·1	0 32·9	Melbourne time ball.
1878.				
Feb. 11	+3 6·5	+3 56·0	0 49·5	Three stars with artificial horizon.
Feb. 25	+3 10·7	+3 54·5	0 43·8	Six stars with artificial horizon.
March 13	+3 14·9	+4 3·8	0 48·9	Six stars with artificial horizon.
July 3	+3 55·4	+4 53·0	0 57·6	St. Helena time ball.
Sept. 19	+4 50·7	+5 3·5	0 12·8	⊙ and ☽ with sea horizon off Start Point.

From this Table it will be seen that up to July 3, 1878, the rate had been subject to a continual acceleration in a gaining direction, but that, from that date to the end of the voyage, the watch had gone slower than its rate. By the daily comparisons which were made throughout the voyage with the two other watches on board, it was found that a sudden change in a losing direction in the rate of this watch took place on August 4; but what the cause of this change was I have not been able to ascertain.

As soon as possible after our arrival in England, this watch was sent to the Liverpool Observatory and submitted to a five weeks' test before being put into the maker's hands to be

cleaned, and that test showed the values of C, T, and R to be as below :—

$$C = -0.0034 \qquad T = 75.42^{\circ}\,F \qquad R = +0.73^{s}.$$

The maker said that when he took the watch to pieces he found that the oil had become deteriorated, but that otherwise he could not find anything to account for the change of rate which had apparently taken place.

The value of the temperature coefficients C and T remain constant for long periods.

On this occasion the maker (who is a thoroughly reliable man) was particularly requested to use every care to avoid in any way altering either the compensating weights on the balance or the timing screws, in order that the change produced by simply substituting oil in good condition for that which had become deteriorated might be ascertained from a comparison of the last test with its performance after being cleaned. As soon as it was cleaned it was again tested, and the result of a five weeks' test showed that the values of C, T, and R were as below :—

$$C = -0.0037 \qquad T = 68.7^{\circ}\,F \qquad R = -0.88^{s}.$$

It will be seen from these figures that the value of C was, practically speaking, unaltered, that the change in the value of T was only slight, and that the watch went about $1^{s}.6$ per day slower with the new oil, probably on account of its being a little fast in the short arcs, in which case it would go rather slower when the balance was vibrating through longer arcs after the watch had been cleaned.

The objection has been sometimes raised to Mr. Hartnup's method of correcting rates for change of temperature, that the values of C and T would need to be frequently redetermined. That such is not the case with a good watch when carefully cleaned and kept in good repair, but that, on the contrary, the values of these two coefficients are nearly constant, will be seen from the following Table, showing the various values of C, T, and R which have been obtained for this watch from the tests to which it has been submitted at various times at the Liverpool Observatory :—

Date of Test.		C	T $^{\circ}$	R ^{s}
August and September	1874	−0.0051	71.28 F	−0.08
April	1876	−0.0035	70.30	−1.63
March—April—May	1877	−0.0037	70.03	+0.50
October and November	1878	−0.0034	75.42	+0.73
November and December	1878	−0.0037	68.70	−0.88

From these figures it will be seen that the value of T has, except in the case of the last two tests, been between 70° and 72° F., and that for the last four tests the value of C has remained almost constant, the abnormal value of C in the first test being probably caused by the rapid acceleration which was being then developed in the rate.

The values of R have been fluctuating, as might be expected in any watch which had been cleaned two or three times in the period under discussion.

On the performance of the Chronometers on board the ship "British Sceptre" during a fifteen months' voyage.

The last voyage on which this watch was used, and to which reference has been made above, was on board the ship "British Sceptre," commanded by Captain Henry Richards. On board this ship were two other chronometers, besides No. 1656 (which we will call for convenience S, standard), and by the kindness of Captain Richards I was enabled to have free access to them, and to all the papers connected with them. He also gave me the comparisons every day throughout the voyage of each of them with S, obtained by observing the simultaneous readings of all three of them. From these comparisons the first and second differences for each pair were obtained each day and tabulated. The mean temperature experienced was also recorded.

One of these chronometers, No. 196 (which we will call A), illustrated very well the advantages to be obtained from a knowledge of the temperature corrections for the rate of even a single watch in working with a set of two or more chronometers on a long voyage.

From the above mentioned comparisons it was found that in a temperature of from 55° to 60° F. the second differences from day to day between S and A were practically $0^{s}\cdot0$, showing that in that temperature the two watches were making the same rate; while in crossing the tropics, with temperatures ranging from 80° to 82° F., the difference of the rates of the same two watches was from $4^{s}\cdot5$ to $5^{s}\cdot0$ per day, A going slower than S by this amount.

All that was known about the going of A was that the chronometer maker, who had rated it in London in the months of May and June 1877, probably in a temperature of say 65° F., more or less, had given $-1^{s}\cdot3$ per day as the rate.

With regard to S the following Table of rates had been obtained in the manner which has been described above:—

Rates of S in various Temperatures.

The rate in	55°	60°	65°	70°	75°	80°	85°	Fahrenheit
was	−0·03	+0·43	+0·71	+0·80	+0·71	+0·43	−0·03	seconds per day.

Under these circumstances it was a matter of certainty that the Greenwich Mean Time (and therefore of course the longitude) indicated by these watches would differ continually—as the temperature varied—and the following Table shows the amount of those differences, obtained on the passage from London to Melbourne:—

Table showing the relative performances of S and A, the rate of A not being corrected for change of Temperature.

Date	First Differences between S and A. By Calculation.			By direct Comparison.			Differences of Greenwich Mean Times indicated.		Mean Temperatures Fahrenheit.
1877.	h	m	s	h	m	s	m	s	°
July 1	0	18	33·6	0	18	36·5	0	2·9	75
8	0	18	47·7	0	19	2·2	0	14·5	79
15	0	19	00·1	0	19	35·2	0	35·2	81
22	0	19	11·6	0	20	9·2	0	57·6	78
29	0	19	24·4	0	20	41·2	1	16·8	72
Aug. 5	0	19	38·7	0	21	4·6	1	25·9	59
12	0	19	50·0	0	21	7·5	1	17·5	58
19	0	20	1·0	0	21	7·9	1	6·9	59
26	0	20	12·4	0	21	9·1	0	56·7	61
Sept. 2	0	20	25·2	0	21	14·1	0	48·9	56
9	0	20	35·1	0	21	13·8	0	38·7	57
16	0	20	45·1	0	21	15·4	0	29·8	58
23	0	20	56·6	0	21	19·8	0	23·2	57
24	0	20	58·1	0	21	19·8	0	21·7	

The errors of these watches on September 24, by account, and also by the Melbourne time signal, were as below:—

S.	m	s	A.	m	s
Error by account	+2	10·6	Error by account	−18	47·5
„ observation	+2	16·2	„ observation	−19	3·6
Error of G.M.T.	0	5·6	Error of G.M.T.	0	16·1
Placing the ship to the West of the true Longitude	0°	1′ 24″	Placing the ship to the East of the true Longitude	0°	4′ 1″·5

Method adopted to ascertain the rates of A in various temperatures.

From the information which has been already given, it will be seen that if the table of rates in various temperatures for S be assumed to be correct, all the data are at hand which are necessary for ascertaining the rates made by A in the various temperatures experienced between London and Melbourne.

The method adopted to find the rate of A in any temperature was as follows:—From the tabulated comparisons of these two watches the difference of the rates made by them was ascertained on every day on which that temperature was experienced as the mean temperature of 24 hours, from the column of second differences; the known rate of S was applied to this difference, and the result gave the rate of A in that temperature.

Thus it was found that on 7 days the mean temperature had been 56°, and on 5 days 80°, and the following calculations were made to ascertain the rates of A in temperatures 56° and 80° F.

Observed Second Differences between S and A.

In temp. 56°		In temp. 80°
s		s
+0·3		−4·8
+0·4		−4·9
+0·0		−4·8
+0·1		−4·9
+0·1	In referring to these second differences,	−4·5
−0·4	+ denotes A gaining on S;	
−0·2	− „ A losing on S.	
Mean +0·04		−4·78 Mean
Rate of S in temp. 56° +0·07		+0·43 Rate of S in temp. 80°
∴ Rate of A in temp. 56° +0·11		−4·35 ∴ Rate of A in temp. 80°

By a series of calculations similar to the above, the subjoined Table was obtained of the

Rates of A in various Temperatures.

Temperature Fahrenheit.	Daily Rates of A.	Temperature Fahrenheit.	Daily Rates of A.
°	s	°	s
53	+0·43	57	+0·03
54	+0·22	58	+0·21
55	+0·37	59	−0·08
56	+0·11	60	−0·06

Temperature Fahrenheit.	Daily Rates of A.	Temperature Fahrenheit.	Daily Rates of A.
°	s	°	s
61	−0·26	74	−2·81
62	−0·20	75	−3·29
63	−0·01	76	−3·56
64	−0·43	77	−3·78
65	−0·79	78	−3·90
66	−1·06	79	−3·97
67	−1·48	80	−4·35
68	−1·61	81	−4·50
*		82	−5·03
73	−2·63	83	−5·43

From an inspection of this Table, it will be seen that the rates found in the way which has been described are not absolutely accurate; it is not to be expected that, where some certain degree of temperature has only occurred on one or two days, the rate for that temperature could be ascertained to a tenth or even half a second. Nevertheless the Table gives a very fair idea of the corrections to be applied. By using the last Table as a sort of general guide, the following Table of rates for A was drawn up for use at sea:—

In Temp.	55°	60°	65°	70°	75°	80°	85°	Fahrenheit
Rate of A =	+0·3	−0·3	−0·7	−1·9	−3·2	−4·3	−6·0	seconds per day.

Advantages obtained by correcting the rate of A for change of temperature.

The "British Sceptre" left Melbourne on November 15, 1877, bound to Madras, and on that day the errors of the two watches, S and A, were ascertained by observing the drop of the time ball, and during the passage the same rates were used for S as had been used on the previous passage, and the rates given in the last Table were used for A. From Madras we went to Coconada, and thence to Gobaulpore, at which port, on the night of February 24-25, 1878, a good set of observations for time were obtained. The relative performances of these two watches on the voyage from Melbourne to Gobaulpore is shown in the following Table:—

* 69°, 70°, 71°, and 72° did not occur as the mean temperature for any 24 hours during the passage.

Table showing the relative performances of S and A during 102 *days, the rates of both being corrected for change of temperature.*

Date.	Differences between S and A. By Calculation.	Differences between S and A. By Comparison.	Differences of the G. M. Times indicated.	Mean Temperatures Fahrenheit.
	h m s	h m s	m s	°
1877. Nov. 15	0 23 3·4	0 23 3·4	0 00·0	61
18	0 23 5·7	0 23 8·4	0 2·7	60
25	0 23 10·4	0 23 16·0	0 5·6	60
Dec. 2	0 23 16·0	0 23 23·0	0 7·0	66
9	0 23 28·3	0 23 36·7	0 8·4	77
16	0 23 58·1	0 24 7·6	0 9·5	82
23	0 24 35·0	0 24 43·5	0 8·5	84
30	0 25 15·2	0 25 23·6	0 8·4	82
1878. Jan. 6	0 25 52·8	0 26 1·4	0 8·6	83
13	0 26 31·5	0 26 37·4	0 5·9	82
20	0 27 7·9	0 27 11·4	0 3·5	81
27	0 27 41·9	0 27 46·0	0 4·1	80
Feb. 3	0 28 15·5	0 28 19·4	0 3·9	82
10	0 28 52·7	0 28 53·8	0 1·1	82
17	0 29 30·4	0 29 28·4	0 2·0	81
25	0 30 10·1	0 30 6·1	0 4·0	

On February 25, 1878, the ship being then at Gobaulpore, the time was obtained from the mean of six sets of observations of stars taken with a sextant and artificial horizon on shore, three of the stars being to the eastward and three to the westward of the meridian, with the following results :—

Errors on Greenwich Mean Time.

	Of S. h m s	Of A. h m s
By account	+0 3 44·3	0 26 25·8
By observation	+0 3 54·5	0 26 11·6
Difference	0 0 10·2	0 0 14·2
Error of longitude	0° 2′ 33″ Westerly	0° 3′ 33″ Westerly.

The rate for A given in London, as has been mentioned above, was $-1^{s}\cdot3$ per day, and that rate agreed very closely with the rate obtained in Melbourne by the time ball, and also with the mean rate made on the passage from London to Melbourne.

It would therefore have appeared more than probable, if nothing had been ascertained about its rates by the comparisons with S, that $-1^s\cdot3$ was a correct sea rate for this watch; if that rate had been used from Melbourne to Gobaulpore, the result would have been as below:—

	h	m	s
Feb. 25. Error of A on G.M.T. by account	−0	22	7·9
„ „ „ observation	−0	26	11·6
(With rates *not* corrected for temperature) difference	0	4	3·7

i.e. error of longitude = 1° 0′ 55″·5 easterly.

By applying the necessary temperature corrections to its rate, this watch indicated a longitude only $3\frac{1}{2}'$ in error; but by using one mean rate in the usual manner, the error accumulated on the same passage would have been over a degree.

Verification of the previously ascertained Tables of Rates for A.

The method has been already explained by which the rates made in various temperatures by A on the passage from London to Melbourne were ascertained from the second differences arising from the daily comparisons of the two watches under consideration. The same method was adopted in order to ascertain what rates A had made on the passage from Melbourne to Gobaulpore in the various temperatures experienced.

It will have been seen above that the G.M.T. deduced from S was in error to the extent of $10^s\cdot2$ on February 25, and as that error had been acquired in 102 days, the mean error of the rate would be $0^s\cdot1$, and therefore R would be $+0^s\cdot9$, instead of $+0^s\cdot8$. This correction was made to the rate of S before making the calculations from which the following Table was obtained of the

Rates of A *in various Temperatures.*

Temp. Fahr. °	Rates of A. s	Temp. Fahr. °	Rates of A. s
58	−0·83	72	−2·61
59	−1·30	74	−3·06
60	−0·34	76	−3·63
61	−0·58	78	−3·84
62	−0·54	79	−4·15
65	−0·89	80	−4·23
66	−1·19	81	−4·36
68	−1·71	82	−4·73
69	−1·70	83	−4·90
71	−2·00	84	−5·41

N.B. Temperatures 63°, 64°, 67°, 70°, 73°, 75°, and 77° were not experienced as the mean temperature for 24 hours during the period referred to by the above Table.

The following Table shows the rates adopted for A on the passage from Bimlipatam (the port at which we completed our cargo) to London. It will be seen that it differs but slightly from the similar Table of rates for the same watch given above as used between Melbourne and Gobaulpore (p. 332).

In Temp.	55°	60°	65°	70°	75°	80°	85°	Fahr.
Rate of A	+0·3	−0·3	−0·8	−1·8	−3·2	−4·3	−5·8	secs. per day.

There is one remark which it is necessary to make about the last two Tables which have been given. The objection may be raised, that the rate given in the last Table for 55° temperature does not correspond with what it apparently ought to be from the rates given in the Table which precedes it for temperatures 58° and 59°. The reason for that is that these two temperatures were each only experienced for two days on the passage under discussion, and the two rates were therefore rejected in favour of the rates obtained on the passage from London to Melbourne, from much more numerous observations in the same two temperatures.

On March 12, 1878, the errors of the two watches on Greenwich Mean Time were obtained by observations of 6 stars (3 east and 3 west of the meridian) taken with a sextant and artificial horizon on shore at Bimlipatam. We left that port on March 19 for London, and on the passage the rates used for A were those given in the last Table. The rates used for S were based on the corrected value for R for that watch, which has been given above, namely $+0^{s}\cdot9$, instead of $+0^{s}\cdot8$ as used during the two preceding passages. They may be found from the Table of rates for that watch which has been already given (p. 328) by applying $+0^{s}\cdot1$ to each rate in that Table.

The next Table shows the results obtained from the two watches during the homeward passage.

Table showing the relative performances of S and A during a six months' passage, the rates of both being corrected for change of temperature.

Date. 1878.	Differences between S and A. By Calculation. h m s	By Comparison. h m s	Differences of G. M. Time indicated. m s	Mean Temperatures Fahrenheit.
March 12	0 31 27·4	0 31 27·4	0 00·0	
				83
17	0 31 55·0	0 31 54·6	0 00·4	
				84
24	0 32 35·5	0 32 34·4	0 1·1	
				86
31	0 33 18·2	0 33 14·9	0 3·3	
				87
April 7	0 34 2·6	0 33 57·7	0 4·9	
				86
14	0 34 45·6	0 34 37·6	0 8·0	
				84

Date. 1878.	Differences between S and A. By Calculation. h m s	Differences between S and A. By Comparison. h m s	Differences of G. M. Time indicated. h s	Mean Temperatures Fahrenheit.
April 21	0 35 26·3	0 35 17·0	0 9·3	
				86
28	0 36 9·3	0 35 59·7	0 9·6	
				83
May 5	0 36 47·8	0 36 38·8	0 9·0	
				78
12	0 37 19·6	0 37 10·6	0 9·0	
				73
19	0 37 44·5	0 37 35·2	0 9·3	
				75
26	0 38 12·0	0 38 2·6	0 9·4	
				73
June 2	0 38 36·5	0 38 27·4	0 9·1	
				71
9	0 38 57·7	0 38 47·3	0 10·4	
				66
16	0 39 10·3	0 38 59·4	0 10·9	
				64
23	0 39 20·3	0 39 8·4	0 11·9	
				64
30	0 39 31·1	0 39 19·2	0 11·9	
				70
July 7	0 39 50·5	0 39 38·5	0 12·0	
				78
14	0 40 21·6	0 40 7·0	0 14·6	
				80
21	0 40 55·0	0 40 34·8	0 20·2	
				81
28	0 41 30·4	0 41 10·2	0 20·2	
				82
Aug. 4	0 42 7·6	0 41 48·6	0 19·0	
				80
11	0 42 42·0	0 42 20·5	0 21·5	
				83
18	0 43 20·2	0 42 49·9	0 30·3	
				82
25	0 43 57·1	0 43 19·0	0 38·1	
				74
Sept. 1	0 44 23·8	0 43 40·4	0 43·4	
				70
8	0 44 43·6	0 44 4·9	0 38·7	
				68
15	0 44 59·0	0 44 26·4	0 32·6	
				66
19	0 45 6·2	0 44 36·7	0 29·5	

Advantageous results obtained by correcting the rates of A for change of temperature.

On July 3, 1878, the errors of the watches were obtained by the St. Helena time ball, as below :—

Errors on G.M.T.

	Of S.	Of A.
	h m s	h m s
By observation	+0 4 53·0	−0 34 34·0
By account	+0 4 55·5	−0 34 43·1
∴ Errors of G.M.T.	0 0 2·5	0 0 9·1
	Placing the ship to the Eastward of correct Longitude	Placing the ship to the Westward of correct Longitude
	0° 0′ 37″·5	0° 2′ 16″·5

On September 19, 1878, the errors on Greenwich Mean Time of the chronometers were ascertained from observations of the Sun and Moon, taken with the sea horizon, Start Point being distant about 1½ mile, the Sun being to the east and the Moon to the west of the meridian; they were as follows:—

Errors on G.M.T.

	Of S.	Of A.
	h m s	h m s
By observation	+0 5 3·5	−0 39 33·2
By account	+0 5 43·0	−0 39 23·2
∴ Errors of G.M.T.	0 0 39·5	0 0 10·0
	Placing the ship to the Eastward of correct Longitude	Placing the ship to the Eastward of correct Longitude
	0° 9′ 52″·5	0° 2′ 30″

If the mean rate which has before been given for A, viz. −1ˢ·3 per day had been used on the voyage from Bimlipatam towards London, the error of the longitude on July 3 (at St. Helena) would have been 1° 10′ 51″, instead of 0° 2′ 16″·5, the error found after correcting the rates for change of temperature.

Again, by applying −1ˢ·3 as the daily rate for the rest of the passage up to September 19, the error of the longitude deduced from A would have been 2° 0′ 18″, instead of 0° 2′ 30″, its amount after correcting the rate for change of temperature.

With regard to the other watch, S, it seems unnecessary to make any further remarks.

I should only like to point out that the error of the longitude found from the mean of these two chronometers, when the rates of both had been corrected for change of temperature, would be 0° 6′ 11″·2 east (in time 0ʰ 0ᵐ 24ˢ·7), and, after a passage of over six months, this is very near perfection.

Conclusion.

In the *Monthly Notices*, vol. xxxv. (1874–75), Nos. 2 and 5, will be found two letters from me to Mr. Hartnup, giving the results obtained on a voyage from England to Calcutta and back, from two chronometers, for which the temperature corrections had been ascertained by Liverpool Observatory tests. When the results obtained on that voyage are combined with the facts which have been given in the present paper concerning the voyage in the "British Sceptre," it may be fairly said that my experience has shown, as far as it goes, that temperature corrections computed by Hartnup's formulæ are invaluable in carrying on time with chronometers at sea.

Notes on a Persian MS. of Ulugh Beigh's Catalogue of Stars belonging to the Royal Astronomical Society.

By E. B. Knobel, Esq.

The MS. which is the subject of the following notes, is a portion of a somewhat complete copy of Ulugh Beigh's Tables recently presented to the Royal Astronomical Society by Mr. Ranyard. This MS. is in Persian, and, from the date given on the last page of the Tables, it was written in the year 1255 Hegira = A.D 1839 for "Dr. James Bird."

The complete MS. is bound up in two parts. Vol. i. consists of Ulugh Beigh's "Introduction to the Catalogue and Knowledge of the Stars," and is very handsomely written and evidently by one hand throughout. Vol. ii. contains the "Samarcand Tables" and Catalogue of Stars, and shows evidence of having been written by two or three different hands.

Our knowledge of Ulugh Beigh's Catalogue of Stars is derived entirely from the translation made by Thomas Hyde and published in 1665; a second edition of this translation was published by Gregory Sharpe, in a complete collection of all Thomas Hyde's works, in 1767, and it is this copy which has been reproduced with notes by Mr. Baily in vol. xiii. of the *Memoirs of the Royal Astronomical Society*.

Hyde's translation was made from three Persian MSS., one in the Library of St. John's College, Oxford, another in the possession of Dr. Pocock, and the third in the Savilian Collection.*

A careful comparison of the Royal Astronomical Society's MS. with Hyde shows over one hundred and twenty differences in the longitudes and latitudes of stars.

A large proportion of these differences are due to errors of that particular kind which I have indicated in my notes to

* The preface to the Catalogue which Hyde gives appears to be the thirteenth Treatise in the third part of Ulugh Beigh's Tables. *See* Sédillot, *Prolegomènes des Tables Astronomiques d'Oloug Beg*, 1853.

Sédillot's translation of Aboul Hhassan's Catalogue,* namely, errors made by confounding certain Persian or Arabic characters in transcribing or translating the original MS.

In the comparison of the Royal Astronomical Society's MS. with Hyde, 26 per cent. of the discrepancies are due to confounding the Yā ي (10) with the Nūn ن (50), and 8 per cent. to mistakes between the Yā (10) and the Lām ل (30) or *vice versâ*. In Professor Schjellerup's comparison of the Copenhagen and St. Petersburg MSS. of Al-Sûfi, by far the largest number of differences he found, viz. 20 per cent., were due to precisely the same cause as in the Ulugh Beigh MSS., that is to say, confounding the Yā with the Nūn; but he notes only 2·7 per cent. of mistakes between the Yā and the Lām. It is a singular fact that, though in these MSS. of Ulugh Beigh and Al-Sûfi we have so much confusion between the Yā (10) and the Nūn (50) and the Yā (10) and the Lām (30), we do not find a single instance in them of confounding the Nūn (50) with the Lām (30).

In the large majority of cases it is difficult to say which is the more correct reading. Where the mistake of 10 for 50 takes place in the *degrees* of longitude or latitude, it is of course easy to make the correction from the description of the star; but as all these discrepancies in the Royal Astronomical Society's MS., with only three exceptions, are in the *minutes* of longitude and latitude, it is then much more difficult to know which reading to adopt. In this MS. the Yā and the Nūn, when combined with other letters, are written exactly alike, with the exception of the diacritical point being placed over the Nūn. Presumably, therefore, we should accept as more correct a redundant letter rather than one which requires less care in writing; that is to say, that a letter with a dot over it should be accepted as more correct than a similarly formed letter without a dot. It is more reasonable to suppose that the dot has been wrongly omitted than that it has been wrongly inserted. The accompanying notes show that this rule is not quite infallible.

The great probability of errors of this kind being made in transcribing or translating Oriental MSS., shows how important it is to be cautious in founding any deduction on old Arabian observations till such probable errors have been eliminated by careful examination of more than one MS.†

The MS. under discussion (a great portion of which is badly written) is useful in affording clues to explain discrepancies which have been found in investigating other Oriental MSS.

In his recently published *Researches on the Motion of the Moon*, Professor Newcomb has discussed the observations of eclipses recorded by Ibn Junis in the Hakemite Tables and

* *Mems. Roy. Ast. Soc.*, vol. xliii. p. 64.

† In the thirteenth century Chrysococca translated a Catalogue of Stars from the Persian containing an error in the *degrees* of Yā (10) for Nūn (50). This was copied by Bullialdus in his *Astronomia Philolaica*, and repeated by Delambre, in his *Histoire de l'Astronomie*, without remark.

translated by Caussin from the Leyden MS. The following of his observations are found to be irreconcilable with the computations:—

"Lunar Eclipse 929, January 27." At the beginning of this eclipse *Arcturus* was observed to be in the east at an altitude of 18°. The Greenwich mean time of observation is $8^h\ 5^m\ 32^s$, and the tabular Greenwich time of geometric phase $9^h\ 4^m\ 20^s$. Clearly, therefore, the recorded altitude of *Arcturus* is much too low; but a highly probable error in an Arabic MS. is to confound the numbers 18 يح, 33 لج, and 38 لح, and so there can be little doubt that the real observed altitude was 33° or 38°, which has been erroneously rendered 18 by transcriber or translator.

"Lunar Eclipse 980, May 2." The altitude of the Moon at the beginning of the eclipse is given as 47° 40′. Professor Newcomb remarks that there is clearly some mistake, as this quantity exceeds the Moon's meridian altitude. The computed altitude of the Moon, Mr. Neison tells me, is 40° 33′. It is most improbable that the Arabic figures 40 and 47 could ever be confounded. But in the latitude of "No. 5 *Ursi Majoris*" in the Royal Astronomical Society's MS. the number 47 is written not very unlike a 41, and a possible explanation is here afforded.

"Lunar Eclipse 983, March 1." The altitude of the Moon when the eclipse began is given as 66°. This is impossible, as it exceeds the meridian altitude.

In examining the positions of stars in the Ulugh Beigh MS., I have noted particularly that the Bā ب (2) is occasionally written so like the Waū ؛ (6) that the two might be easily confounded. In the longitude of the star "No. 4 *Extra Figuram Libræ*" the number 22 is written like the number 26 in the longitude of "No. 5 *Scorpionis*." Again, in the longitude of "No. 14 *Capricorni*" the Waū (6) is written so that it closely resembles the Bā (2) in the longitude of "No. 2 *Extra Figuram Libræ*." Other similar cases are found in the longitudes of "No. 27 *Capricorni*" and "No. 5 *Ferœ*." In the latter the Bā (2) is quite like the Waū (6) in the longitude of "No. 3 *Coronæ Australis*."

In comparing the figures 60 to 69 as we find them written in this MS., the two which resemble each other are the 66 and 62, and from the instances given above, I think the probability of the original MS. of Ibn Junis giving 62° as the altitude, instead of 66° as translated by Caussin, amounts almost to a certainty.

Mr. Neison tells me that the computed altitude of the Moon comes out 62° 40′.

"Lunar Eclipse 986, December 18." When the eclipse was visible the Moon was observed in the west at an altitude of 24°. Ibn Junis estimated the height of the Moon at the moment of contact ("*attouchement*") to be 50° 30′. This second altitude is of

course a great deal too high. It is a rather singular fact that in the longitude of "No. 2 *Gallinæ*" in the Ulugh Beigh MS. the numbers 28 and 50 are written side by side, and in such a manner that it is almost inevitable that the number 28 would be translated 50, and hence an explanation is suggested of the discrepancy in Ibn Junis.

"Lunar Eclipse 1002, March 1." The altitude of *Arcturus* at the commencement is given as 52° in the East, and at the end as 35°. The altitude of another star, supposed to be *α Aurigæ*, at the commencement was 14° in the west. The discrepancies here are very difficult to explain. The printed Arabic of Ibn Junis, which I have before me, gives 12° as the altitude of "Al-Simak Al-Ramih" at the commencement, and 35° for "Al-Ramih" at the end, the same designation not being used for both altitudes. Though the name "Al-Simak" is applied to another star besides *Arcturus*, viz. *α Virginis*, I cannot find the name "Al-Ramih" given to any other star except *α Boötis*. Caussin suggests that the altitude of 12° at the commencement might accord for *Arcturus*, with 35° at the end of the eclipse; but this disagrees with Professor Newcomb's computations. Time has not allowed me to compute the position of "Al-Simak Al-Aezal" for the commencement of the eclipse. With regard to the star with the altitude 14°, Caussin states that the name "Al-Hadi" is not to be found in Ulugh Beigh nor in Al-Sûfi, but he found a similar name in Scaliger for *α Aurigæ*.

In searching through Al-Sûfi I find the identical word حادي, Hâdi, applied to *α Tauri*, which is there called "Hadi al-Nadjm, The Driver of the *Pleiades*." This point was evidently missed by Caussin in his examination of Al-Sûfi. The altitude of *α Tauri* in the west at 14° would not be very discordant with an altitude of 12° in the east for "Al-Simak Al-Aezal" = *α Virginis*.

M. L. A. Sédillot, in his *Mémoire sur les Instruments astronomiques des Arabes*, confines the name "Al-Hâdi" to the star *α Tauri*, and says nothing about it being given to *α Aurigæ*. I am therefore inclined to think that Scaliger's application of the name to *α Aurigæ* was in error.

"Solar Eclipse 1004, January 23." When the eclipse began to appear on the disk the Sun was observed to be in the west at an altitude of 16° 30′; his altitude at the commencement of the eclipse was estimated to be 18° 30′.

In the comparison of the Copenhagen and St. Petersburg MSS. of Al-Sûfi, Professor Schjellerup gives seven instances in those MSS. of the figure 6 being written for 7, or *vice versâ*. It seems therefore not improbable that there has been a similar error in transcribing or translating the above altitude of 16° 30′, and for this we should read 17° 30′.

In the notes which follow, the first column gives Baily's number of the star, and in the second column Ulugh Beigh's

designation is given. In the notes H means Baily's edition of Hyde.

The magnitudes given by Ulugh Beigh are really those of Al-Sûfi, and they have never been properly translated. In Hyde's edition there are many discrepancies between the printed Persian and the Latin translation. Baily gives the magnitudes in whole numbers without the thirds of a magnitude given in the original. I have endeavoured to supply this omission by giving a complete translation of the magnitudes as found in the Royal Astronomical Society's MS. with notes, comparing them with Hyde, and with Sharpe's second edition of his translation. In the original, against some stars there is placed the initial letter of the word كبير, Kabīr, signifying "large," and against others the initial of صغير, Saghīr, "small." So that ك ج = mag. 3–2 and ص ج = mag. 3–4.

Baily's No.	Ulugh Beigh's No.	Notes.
4	4 Ursi Minoris.	Long. 3^s 17° 43′. H. 3^s 17° 13′.
7	7 „ „	Lat. 75° 41′. H. 75° 9′.
9	1 Ursi Majoris.	Long. 3^s 14° 15′. H. 3^s 14° 55′.
11	3 „ „	Lat. 43° 45′. Baily says "the latitude in the first edition (Hyde's translation) is 13° 45′, which is a true translation of the Persian, but in Sharpe's edition it is altered to 43° 45′ which is the more correct value." The true translation of the Persian in the R.A.S. MS. is 43° 45′.
22	14 „ „	Lat. 37° 0′. H. 36° 0′.
23	15 „ „	Lat. 37° 0′. H. 33° 21′. The latitude of 22 has been copied again, and the proper latitude of 23 given to 24.
42	7 Ex. hanc Fig.	Lat. 20° 15′. H. 29° 15′.
71	28 Draconis.	Lat. 60° 21′. H. 65° 21′.
77	3 Cephei.	Long. 1^s 27° 17′. H. 0^s 27° 37′.
83	9 „	Long. 0^s 5° 55′. Baily says, "the printed copies have 5^s 5° 55′, which is evidently erroneous"; and he alters it to 0^s 5° 55′, as it is in the R.A.S. MS.
87	2 Ex. hanc Fig.	Long. 0^s 9° 4′. H. 0^s 9° 25′.
90	3 Vociferatoris.	Lat. 60° 23′. H. 60° 33′.
109	22 „	Lat. 25° 5′. H. 25° 0′. The latitude in the R.A.S. MS. is the same as in the Pocock MS. referred to by Baily.
110	1 Ex. hanc Fig.	Long. 6^s 36° 31′. This is a correct translation, but H. 6^s 16° 31′ is of course the more correct longitude. The latitude of this star is omitted.
112	2 Coronæ.	Lat. 46° 34′. H. 46° 24′.
114	4 „	Long. 7^s 3° 28′. H. 7^s 3° 40′.

Baily's No.	Ulugh Beigh's No.	Notes.
123–130	5–12 Incumbentis Genubus.	Longitudes omitted.
132–136	14–18 „	Latitudes omitted.
147	1 Ex. hanc Fig.	Long. $7^s\ 25°\ 13'$. H. $7^s\ 24°\ 13'$.
150	3 Shelyâk.	Long. $9^s\ 11°\ 55'$. H. $9^s\ 11°\ 10'$.
154	7 „	Lat. 16° 21′. H. 56° 21′.
157	10 „	Lat. 14° 36′. H. 54° 36′.
159	2 Gallinæ.	In the longitude of this star, the character representing 28° is almost identical with that used for 50° in the latitude, and the two would be inevitably confounded. The character representing 50 is not here the Arabic letter Nūn ن, but what is called by the Arabs an Indian figure.
164	7 „	Lat. 69° 42′. H. 69° 52′.
173	16 „	Lat. 64° 24′. The Kāf (20) in the latitude of this star might be easily confounded with a Lām (30).
177	1 Inthronatæ.	Lat. 43° 46′. H. 43° 45′.
194	5 Bershâush.	Lat. 31° 0′. H. 34° 0′.
203	14 „	Lat. 21° 20′. H. 20° 21′.
210	21 „	Lat. 18° 14′. H. 18° 54′.
211	22 „	Lat. 21° 18′. H. 21° 48′.
218	3 Ex. hanc Fig.	Long. $2^s\ 14°\ 28'$. H. $1^s\ 14°\ 28'$.
219	1 Tenentis Habenas.	Long. $2^s\ 22°\ 22'$. H. $2^s\ 2°\ 22'$. Baily remarks that the longitude of this star is 20° too little. In the R.A.S. MS. the longitude is given correctly.
220	2 „ „	Long. $2^s\ 21°\ 25'$. H. $2^s\ 21°\ 55'$.
232	1 Serpentarii.	Lat. 34° 11′. H. 35° 51′.
235	4 „	Lat. 12° 33′. H. 32° 33′.
248	17 „	Long. $8^s\ 14°\ 15'$. H. $8^s\ 14°\ 55'$.
252	21 „	Lat. 3° 48′. H. 3° 18′.
257	2 Ex. hanc Fig.	Long. $8^s\ 22°\ 17'$. H. $8^s\ 22°\ 37'$.
271	11 Serpentis.	Lat. 14° 15′. H. 16° 15′.
301	3 Delphini.	Lat. 27° 16′. H. 27° 36′.
305	7 „	Lat. 32° 54′. H. 32° 55′.
312	4 Sectionis Equi.	Lat. 24° 16′. H. 24° 36′.
319	7 Equi Majoris.	Lat. 24° 45′. H. 34° 45′.
323	11 „ „	Long. $11^s\ 18°\ 25'$. H. $11^s\ 8°\ 25'$.
325	13 „ „	Lat. 14° 25′. H. 14° 15′.
330	18 „ „	Long. $11^s\ 11°\ 22'$. H. $11^s\ 11°\ 34'$.

Baily's No.	Ulugh Beigh's No.	Notes.
334	2 Mulieris Catenatæ.	Long. 0ˢ 13° 55′. This is evidently the longitude of 335 copied by mistake for this star, the proper longitude, H. 0ˢ 15° 46′, being altogether omitted.
347	15 „ „	Lat. 27° 16′. H. 27° 36′.
361	2 Arietis.	Lat. 7° 11′. H. 7° 51′.
372	13 „	Long. 1ˢ 4° 15′. H. 1ˢ 4° 55′.
377	5 Ex. hanc Fig.	Long. 1ˢ 8° 15′. H. 1ˢ 8° 55′.
381	4 Tauri.	Long. 1ˢ 53° 52′. H. 1ˢ 13° 52′. This longitude is unmistakable, as the diacritical point is carefully put over both Nūns (50).
382	5 „	Long. 1ˢ 19° 15′. H. 1ˢ 19° 55′. Here there is no diacritical point, and the character must be translated as a Yā (10).
385	8 „	Long. 1ˢ 23° 24′. H. 1ˢ 23° 22′.
392	15 „	Lat. 2° 52′. H. 2° 54′.
395	18 „	The longitude and latitude of 18 Tauri are omitted. Stars 19–30 are numbered 18–29. The longitude of 30 is numbered correctly, but has the latitude of 31 against it. There is no latitude against the longitude of 31. No. 32 has the correct coordinates.
417	8 Ex. hanc Fig.	Long. 2ˢ 17° 13′. H. 2ˢ 17° 43′.
432	12 Gemellorum.	Long. 3ˢ 6° 18′. H. 3ˢ 6° 58′.
439	1 Ex. hanc Fig.	Long. 0ˢ 23° 13′. H. 2ˢ 23° 13′.
449	4 Cancri.	Long. 3ˢ 29° 34′. H. 3ˢ 29° 35′.
450	5 „	Long. 4ˢ 0° 13′. H. 4ˢ 0° 43′. The R.A.S. MS. has the same longitude as the Pocock MS.
453	8 „	Long. 3ˢ 23° 17′. H. 3ˢ 23° 37′.
464–485	6–27 Leonis.	Magnitudes omitted.
471	13 Leonis.	Lat. 3° 58′. H. 3° 57′.
473	15 „	Long. 4ˢ 28° 27′. H. 4ˢ 28° 37′.
484–501	8–25 „	The longitudes and latitudes of these stars should all be shifted down one line. The elements of 8 are omitted and subsequently inserted as 26.
495	2 Virginis.	Long. 6ˢ 16° 25′. H. 5ˢ 16° 25′.
499	6 „	Long. 6ˢ 27° 13′; Lat. 30° 14′. H. Long. 5ˢ 27° 7′; Lat. 1° 30′. It is difficult to explain the large error in the latitude in the R.A.S. MS. The description and the magnitude of the star agree with Hyde. The MS. is here so clearly written, it does not admit of mistake in translation.
510	17 „	Long. 0ˢ 17° 19′. H. 6ˢ 17° 19′.
511	18 „	Long. 6ˢ 18° 15′. H. 6ˢ 18° 55′.
513	20 „	Lat. 1° 9′. H. 1° 30′.

Baily's No.	Ulugh Beigh's No.	Notes.
526	1 Libræ.	Lat. 0° 42′. H. 0° 45′. It would seem that the numbers 42 and 45 in some modes of writing Persian are likely to be confounded, for Baily notes that the St. John's College MS. gives 0° 45′ as the latitude to 518, whereas the other MSS. examined by Hyde give 0° 42′. *See* also No. 833. In the R.A.S. MS. it is impossible to confound 42 and 45.
537	4 Ex. hanc Fig.	Long. 22° 25′. The Kāf (20) and Bā (2) are here written very like the Kāf (20) and Waū (6) in the longitude of 547, and the one might be translated for the other.
543	1 Scorpionis.	Long. 7^s 25° 24′. H. 7^s 25° 22′. There is no doubt it is written 24′ in the R.A.S. MS.; but with very little less care in writing, it might be mistaken for 22.
552	10 „	Long. 7^s 28° 53′. H. 7^s 28° 13′.
559	17 „	Long. 8^s 17° 15′. H. 8^s 17° 55′.
566	3 Ex. hanc Fig.	Lat. 20° 15′. H. 4° 15′. Here the Dal (4) has been mistaken for a Kāf (20), which in the R.A.S. MS. is a probable error. For a similar error, *see* Schjellerup's *Al-Sûfi*, p. 203, note 3.
575	9 Sagittarii.	Lat. 12° 0′. H. 2° 0′.
577	11 „	Long. 9^s 8° 15′. Lat. 3° 0′. H. Long. 9^s 8° 55′. Lat. 2° 0′.
578	12 „	Lat. 3° 6′. H. 3° 15′.
605	8 Capricorni.	Lat. 0° 16′. H. 0° 36′.
611	14 „	Long. 10^s 9° 56′. H. 10^s 9° 16′. The Waū (6) in this longitude is written exactly like the Bā (2) in the longitude of 535.
613	16 „	Lat. 4° 16′. H. 4° 36′. In the R.A.S. MS. it may be 16 or 36.
616	19 „	Long. 10^s 0° 1′. H. 10^s 6° 1′.
617	20 „	Long. 10^s 9° 15′. H. 10^s 9° 55′.
618	21 „	Long. 10^s 2° 34′. H. 10^s 12° 34′.
624	27 „	Long. 10^s 16° 31′. The Waū (6), is here written exactly like the Bā (2) in No. 535.
632	7 Effusoris Aquæ.	Long. 10^s 5° 25′. H. 10^s 5° 22′.
633	8 „ „	Lat. 8° 41′. H. 8° 9′.
634	9 „ „	Lat. 8° 9′. H. 8° 0′.
635–640	10–15 „ „	The latitude of 635 has been written against 640, and the latitudes of 636–640 are shifted up one line.
636	11 „ „	Long. 11^s 1° 15′. H. 11^s 1° 7′.
640	15 „ „	Lat. 1° 55′. H. 1° 15′.
650	25 „ „	Long. 11^s 8° 18′. H. 11^s 8° 58′.

Baily's No.	Ulugh Beigh's No.	Notes.
657	32 Effusoris Aquæ	Lat. 14° 0′. H. 11° 0′.
658	33 ,, ,,	Lat. 15° 30′. H. 14° 30′.
664	39 ,, ,,	Lat. 16° 17′. H. 16° 57′.
671	1 Piscis.	Lat. 10° 54′. H. 8° 54′.
681	11 ,,	Long. 0^s 6° 15′. H. 0^s 6° 55′.
682	12 ,,	Lat. 1° 52′. H. 1° 12′.
683	13 ,,	Lat. 6° 0′. H. 0° 0′. Baily's note to this star is, "Although the MSS. and printed copies have the latitude 6° 0′ south, yet there can be no question, from the description of the position of this star, that it is erroneous, and that it is very near the ecliptic. I have therefore corrected it." The latitude has evidently been taken from an erroneous copy of Ptolemy, for we find the same latitude of 6° 0′ given to this star in the editions of the *Almagest* of Halma and Grynæus, and also in Al-Sûfi.
684	14 ,,	Lat. 1° 29′. H. 1° 39′.
685	15 ,,	This star is omitted from its proper order and put last, following 704.
696	26 ,,	Long. 0^s 57° 34′. H. 0^s 17° 34′.
702	32 ,,	Long. 0^s 20° 15′. H. 0^s 20° 55′.
708	4 Ex. hanc Fig.	Long. 11^s 25° 13′. H. 11^s 22° 13′.
716	8 Ceti.	Long. 0^s 22° 17′. H. 0^s 22° 37′.
719	11 ,,	Lat. 18° 51′. H. 28° 51′.
728	20 ,,	Lat. 16° 0′. H. 16° 6′.
730	22 ,,	Omitted in its place, but subsequently inserted between 26 and 27 *Gigantis*.
748	18 Gigantis.	Lat. 8° 54′. H. 7° 54′.
756	26 ,,	Long. 2^s 14° 32′. H. 2^s 14° 34′.
759	29 ,,	Long. 2^s 11° 15′. H. 2^s 11° 55′.
766	36 ,,	Omitted in this constellation, but subsequently inserted between 24 and 25 *Fluminis*. Lat. 30° 25′. H. 30° 24′.
801	33 Fluminis.	Long. 1^s 0° 24′. H. 1^s 0° 25′.
806	4 Leporis.	Long. 2^s 9° 47′. H. 2^s 9° 43′.
810	8 ,,	Long. 2^s 11° 40′. H. 2^s 11° 43′.
815	1 Canis Majoris.	Lat. 36° 30′. H. 39° 30′.
821	7 ,, ,,	Lat. 41° 19′. Baily remarks, "The Persian copies have the latitude 45° 19′, which does not agree with the description of the star. Hyde's translation has 41° 19′, but I know not on what authority; yet, as it agrees better with the true position of the star, I have retained it." The R.A.S. MS. gives 41° 19′, exactly the same as Hyde, which evidently differs from the three MSS. he examined.

Baily's No.	Ulugh Beigh's No.	Notes.
832	18 Canis Majoris	Long. 3^s 21° 25′. Here the R.A.S. MS. agrees with H. (Sharpe's edition of Hyde), and differs from Hyde's translation, which gives 3^s 11° 25′.
833	1 Ex. hanc Fig.	Lat. 22° 45′. H. 22° 42′. The R.A.S. MS. agrees with that of St. John's College.
836	4 ,,	Long. 3^s 1° 8′. H. 3^s 1° 7′.
840	8 ,,	Long. 2^s 20° 15′. Lat. 57° 30′. H. Long. 2^s 20° 55.′ Lat. 58° 30′.
841	9 ,,	Lat. 58° 30′. H. 59° 30′.
848	3 Navis.	Long. 3^s 18° 13′. H. 3^s 28° 13′.
850	5 ,,	Long. 3^s 25° 22′. H. 3^s 24° 22′.
865	20 ,,	Long. 4^s 9° 55′. H. 4^s 9° 59′.
886	41 ,,	Lat. 60° 15′. H. 62° 15′. Baily says "this latitude is 3° too little." It is probably copied from Al-Sûfi,* or from copies of the *Almagest* similar to those of Grynæus, Halma, and Trapezuntius. The discrepancy in the R.A.S. MS. is probably due to transcriber.
888	43 ,,	Long. 5^s 8° 31′. H. 3^s 8° 31′.
889	44 ,,	Baily says that neither of these stars was observed by Ulugh Beigh, and he does not give their longitudes and latitudes. The R.A.S. MS. gives these elements, but they are simply the longitudes and latitudes of the *Almagest* copied without alteration or reduction. The magnitudes, however, are Al-Sûfi's.
890	45 ,,	
908	18 Hydri.	Long. 5^s 12° 17′. H. 5^s 12° 37′. In the R.A.S. MS. it may be 17 or 37.
914	24 ,,	Long. 6^s 18° 15′. H. 6^s 18° 55′.
927-931	3–7 Corvi.	In the constellation *Corvus* the stars 4–7 should be numbered 3–6. No. 7 is omitted altogether, but the transcriber evidently imagined the omitted star was No. 3, the longitude and latitude of which he has inserted between 14 and 15 *Centauri*.
941	10 Centauri.	Long. 7^s 11° 16′. H. 7^s 11° 6′.
949	18 ,,	Lat. 34° 48′. H. 32° 48′.
956	25 ,,	Long. 6^s 21° 15′. H. 6^s 21° 55′.
965	34 ,,	Long. 6^s 0° 11′; Lat. 15° 20′. H. 7^s 0° 51′; Lat. 55° 20′.
970–979	2–11 Feræ.	The latitudes of these stars have all been shifted down one line and are not against their proper longitudes. A space then follows in the column of longitudes, after which the coordinates are correctly copied.

* *Vide* Schjellerup's *Al-Sûfi*, p. 232.

Baily's No.	Ulugh Beigh's No.	Notes.
973	5 Feræ	Long. 7ˢ 22° 37′. 22 might here be translated 26, the Bā is exactly the Waū in the longitude of 997, 3 *Coronæ Australis*.
978	10 „	Long. 7ˢ 25° 21′. H. 7ˢ 25° 41′.
987	19 „	Long. 7ˢ 16° 18′. H. 7ˢ 16° 58′.

Star Magnitudes.

Stellæ Ursi Minoris.

No.	Mag.	No.	Mag.	No.	Mag.
1	3	3	4	6	2
2	4	4	4	7	3
		5	5-4		

Extra hanc Figuram.

No.	Mag.
1	4[1]

[1] Mag. Hyde Lat. 4 Pers. 3
„ Sharpe „ 3 „ 3

Stellæ Ursi Majoris.

No.	Mag.	No.	Mag.	No.	Mag.
1	4	10	4–5	19	3–2
2	5	11	3	20	3–4
3	5	12	3–4	21	3–4
4	5	13	3–4	22	3–4
5	5	14	5–4	23	3–4
6	5	15	5–4	24	3[2]
7	4–5[1]	16	2	25	2
8	4	17	3–2	26	2
9	4	18	3–4	27	2

[1] Mag. Hyde Lat. 4–3 Pers. 4–5
[2] „ „ 3–4

Extra hanc Figuram.

No.	Mag.	No.	Mag.	No.	Mag.
1	3	4	4	6	4
2	5	5	4	7	6
	4			8	6

Stellæ Draconis.

No.	Mag.	No.	Mag.	No.	Mag.
1	5	11	4	22	5
2	4	12	4–3	23	5
3	3–2[1]	13	5–4	24	3
4	4–3[2]	14	5–4	25	3
5	5–4[3]	15	5–4	26	4
6	5	16	5–4	27	3–4
7	5	17	4	28	5–4
8	5	18	4	29	3–4
9	5[4]	19	4–3	30	3–4
10	3[5]	20	6	31	3–4
		21	6		

[1] Mag. Hyde Lat. 3 Pers. 3–4
[2] „ „ „ 4 „ 4–3
[3] „ „ 3–2
[4] „ „ Lat. 5 Pers. 5–6
[5] „ „ „ 3–4 „ 3.

Stellæ Cephei.

No.	Mag.	No.	Mag.	No.	Mag.
1	5–4	5	4	8	4–3
2	4	6	4	9	5
3	4–3	7	5	10	4
4	3			11	6

Extra hanc Figuram.

No.	Mag.	No.	Mag.
1	5–4	2	4–3

Stellæ Vociferatoris (Boötes).

No.	Mag.	No.	Mag.	No.	Mag.
1	5–4	8	4–5[2]	16	3
2	5–4	9	4–5	17	4
3	5–4	10	5–4[3]	18	4
4	5	11	5	19	4[5]
5	3	12	5[4]	20	3
6	4–3	13	5	21	4
7	4–3[1]	14	5	22	4[6]
		15	5		

[1] Mag. Hyde Lat. 4–3 Pers. 4
[2] „ „ „ 4–5 „ 4–3
[3] „ „ „ 5–4 „ 5–6
[4] „ „ „ 5 „ 5–4
[5] „ „ 4–3
[6] „ „ Pers. 9 Sharpe „ 4

Extra hanc Figuram.

No.	Mag.
1	1

Stellæ Coronæ.

No.	Mag.	No.	Mag.	No.	Mag.
1	2	4	6	6	4
2	4	5	4	7	4
3	4[1]			8	4

[1] Mag. Hyde 4–5

Stellæ Incumbentis Genubus (Hercules).

No.	Mag.	No.	Mag.	No.	Mag.
1	3–4	10	4	20	6
2	3	11	3	21	6
3	3–4	12	4	22	6
4	4–5	13	5[3]	23	4
5	5[1]	14	5[4]	24	4
6	4[2]	15	4[5]	25	4[6]
7	4	16	5	26	4
8	4	17	4	27	4
9	4	18	4	28	5
		19	4		

[1] Mag. Hyde 3
[2] ,, ,, 5
[3] ,, ,, 5–6
[4] Mag. Hyde 5–6
[5] ,, ,, 4–3
[6] ,, ,, 4–3

Extra hanc Figuram.

No.	Mag.
1	4

Stellæ Shelyâk (Lyra).

No.	Mag.	No.	Mag.	No.	Mag.
1	1	4	4	8	4[4]
2	4–3	5	4[1]	9	3
3	4–3	6	4[2]	10	5
		7	3[3]		

[1] Mag. Hyde 4–5
[2] ,, ,, 4–5
[3] Mag. Hyde 3–4
[4] ,, ,, 4–5

Stellæ Gallinæ (*Cygnus*).

No.	Mag.	No.	Mag.	No.	Mag.
1	3[1]	7	4[4]	12	3
2	6[2]	8	4	13	4
3	5	9	4	14	4
4	6[3]	10	3	15	4
5	2	11	4[4]	16	4
6	3			17	5

[1] Mag. Hyde 3–4
[2] „ „ 6–5
[3] „ „ 3–2
[4] Mag. Hyde 4–5
[5] „ „ 4–5

Extra hanc Figuram.

No.	Mag.	No.	Mag.
1	4	2	4

Stellæ Inthronatæ (*Cassiopeia*).

No.	Mag.	No.	Mag.	No.	Mag.
1	4[1]	5	3	10	6
2	3	6	4	11	4[5]
3	4	7	4[3]	12	3
4	3[2]	8	4[4]	13	6
		9	5		

[1] Mag. Hyde 4–3
[2] „ „ 3–2
[3] „ „ 4–5
[4] Mag. Hyde 4–5
[5] „ „ 4–5

Stellæ Bershâush (*Perseus*).

No.	Mag.	No.	Mag.	No.	Mag.
1	nebulosa	10	3	18	4
2	4	11	4	19	4
3	3[1]	12	2	20	5
4	4–5	13	4–5[2]	21	5
5	5	14	omitted[3]	22	4
6	4	15	4	23	3
7	2	16	4	24	4
8	4	17	4	25	3–4
9	4			26	3–4[4]

[1] Mag. Hyde 3–4
[2] „ „ 4–5
[3] Mag. Hyde 4–5
[4] „ „ 3

Extra hanc Figuram.

No.	Mag.	No.	Mag.	No.	Mag.
1	5–6	2	5–6	3	5

Stellæ Tenentis Habenas (Auriga).

No.	Mag.	No.	Mag.	No.	Mag.
1	4	5	5	10	3[2]
2	5	6	3	11	2
3	1	7	1[1]	12	6
4	2	8	4	13	6
		9	4		

[1] Mag. Hyde 4 | [2] Mag. Hyde 3–4

Stellæ Serpentarii (Ophiuchus).

No.	Mag.	No.	Mag.	No.	Mag.
1	3–4[1]	9	5[5]	17	5
2	3[2]	10	4[6]	18	5–6
3	4[3]	11	5	19	3
4	4	12	3	20	5
5	4–3	13	4–5	21	5
6	4	14	4–5	22	5
7	3	15	4–3	23	5
8	3[4]	16	4–5	24	5

[1] Mag. Hyde 3
[2] „ „ 3–4
[3] „ „ Lat. 4 Pers. 3
„ Sharpe „ 3 „ 3
[4] „ Hyde 3–4
[5] „ „ 5–4
[6] „ „ 4–3

Extra hanc Figuram.

No.	Mag.	No.	Mag.	No.	Mag.
1	4	3	4	4	4
2	4			5	4

Stellæ Serpentis.

No.	Mag.	No.	Mag.	No.	Mag.
1	4	7	3[4]	13	4
2	4–5	8	4	14	4[5]
3	3[1]	9	3	15	4
4	3[2]	10	3–4	16	4
5	5	11	4	17	4[6]
6	4[3]	12	5	18	4

[1] Mag. Hyde 3–4
[2] „ „ 3–4
[3] „ „ 4–5
[4] Mag. Hyde 3–4
[5] „ „ 4–3
[6] „ „ 4–3

Stellæ Sagittæ.

No.	Mag.	No.	Mag.	No.	Mag.
1	4	3	5	4	5
2	6			5	5

Stellæ Aquilæ.

No.	Mag.	No.	Mag.	No.	Mag.
1	6	4	5	7	6
2	3[1]	5	3	8	6
3	2[2]	6	6	9	3

[1] Mag. Hyde 3–4
[2] Mag. Hyde 2–3

Extra hanc Figuram.

No.	Mag.	No.	Mag.	No.	Mag.
1	3[1]	3	3[2]	5	2[4]
2	3	4	4[3]	6	3[5]

[1] Mag. Hyde Lat. 3 Pers. 3–4
„ Sharpe „ 3–4 „ 3–4
[2] „ Hyde 3–4
[3] „ „ 4–5
[4] „ „ 5
[5] „ „ 3–4

Stellæ Delphini.

No.	Mag.	No.	Mag.	No.	Mag.
1	4[1]	4	3[2]	8	6
2	6	5	3[3]	9	6
3	6	6	3–4	10	6
		7	3–4		

[1] Mag. Hyde 4–5
[2] Mag. Hyde 3–4
[3] Mag. Hyde 3–4

Stellæ Sectionis Equi (*Equuleus*).

No.	Mag.	No.	Mag.	No.	Mag.
1	4	2	6	4	5–6
		3	5–6		

Stellæ Equi Majoris (*Pegasus*).

No.	Mag.	No.	Mag.	No.	Mag.
1	2–3	8	5[1]	14	5–6
2	2–3	9	4–3	15	3–4
3	2–3	10	3–2[2]	16	5–6
4	2–3	11	3–4	17	3
5	4	12	3–4[3]	18	4
6	4	13	5–6	19	4
7	3			20	4

[1] Mag. Hyde Lat. 5 Pers. 5–6
[2] ,, ,, 4–3
[3] ,, ,, 4–5

Stellæ Mulieris Catenatæ (*Andromeda*).

No.	Mag.	No.	Mag.	No.	Mag.
1	3–4	9	4–3	16	4
2	4	10	4–5	17	4–3
3	4	11	5–4	18	4–3
4	4–5	12	2–3	19	4
5	4–5	13	4	20	5
6	5–4	14	4–5	21	5–6
7	4–3	15	3	22	5–6[1]
8	4–3			23	4–3

[1] Mag. Hyde Lat. 5 Pers. 5–6

Stellæ Trianguli.

No.	Mag.	No.	Mag.	No.	Mag.
1	3	2	3	4	3[2]
		3	5–6[1]		

[1] Mag. Hyde 5 [2] Mag. Hyde 3–4

Stellæ Arietis.

No.	Mag.	No.	Mag.	No.	Mag.
1	3–4	5	5	10	4
2	3	6	6	11	5
3	5–6	7	5	12	5
4	5–6	8	4	13	4
			4		

Extra hanc Figuram.

No.	Mag.	No.	Mag.	No.	Mag.
1	3–4[1]	3	5	4	5
2	4			5	5–6

[1] Mag. Hyde 3–2

Stellæ Tauri.

No.	Mag.	No.	Mag.	No.	Mag.
1	4	12	3–4	22	4
2	4	13	3–4	23	5
3	4–3	14	1	24	6
4	4–3	15	3–4[2]	25	5
5	6	16	5	26	5
6	3	17	5	27	5
7	4	18	5	28	5
8	4[1]	19	3	29	5
9	4	20	4	30	5
10	4	21	4	31	5
11	3–4			32	5[3]

[1] Mag. Hyde 4–3 | [2] Mag. Hyde 3 | [3] Mag. Hyde 4

Extra hanc Figuram.

No.	Mag.	No.	Mag.	No.	Mag.
1	5[1]	5	5	8	5
2	5	6	5[2]	9	5[4]
3	5	7	4[3]	10	5[5]
4	5			11	5

[1] Mag. Hyde 4 | [3] Mag. Hyde 5

[2] ,, ,, 6–7 | [4] ,, ,, 5–4

[5] Mag. Hyde. Lat. 5 Pers. 5–6

Stellæ Gemellorum.

No.	Mag.	No.	Mag.	No.	Mag.
1	2	7	4–3	13	3–4
2	2	8	5–6	14	4–3
3	4–3	9	5	15	4–3
4		10	3–4	16	3–4
5		11	3	17	3
6	4	12	4–3	18	3[1]

[1] Mag. Hyde 4

Extra hanc Figuram.

No.	Mag.	No.	Mag.	No.	Mag.
1	4–5	3	5–6	6	5–6
2	4–5	4	5–6	7	4–5
		5	5–6		

Stellæ Cancri.

No.	Mag.	No.	Mag.	No.	Mag.
1	nebulosa.	4	4	7	4
2	4–5	5	4	8	5–6
3	4–5	6	4	9	4

Extra hanc Figuram.

No.	Mag.	No.	Mag.	No.	Mag.
1	4–5	2	4–5	4	5
		3	5		

Stellæ Leonis.

No.	Mag.	No.	Mag.	No.	
1	4	4	3[2]	6 to 27	Magnitudes omitted.[3]
2	4	5	3		
3	3[1]				

[1] Mag. Hyde 3–4 [2] Mag. Hyde 3–2

[3] Mag. Hyde:—

No.	Mag.	No.	Mag.	No.		Mag.
6	2	14	4	22		3
7	3	15	4	23		3–4
8	1	16	6	24	Lat.	4–3
9	4	17	6		Pers.	4
10	5	18	6	25		4
11	6	19	5–4	26		5
12	6	20	2	27		1
13	4–3	21	5			

Extra hanc Figuram.

No.	Mag.	No.	Mag.	No.	Mag.
1	5	4	5	6	5
2	5	5	5	7	5
3	4[1]			8	5

[1] Mag. Hyde 4–5

Stellæ Virginis.

No.	Mag.	No.	Mag.	No.	Mag.
1	5	10	3	18	5–6
2	5	11	5–6	19	5–6
3	5	12	6	20	5–6
4	5	13	3	21	5
5	3	14	1–2	22	4
6	3	15	3–4	23	4
7	3	16	5–6	24	4
8	6	17	6	25	4
9	4			26	4[1]

[1] Mag. Hyde 4–3

Extra hanc Figuram.

No.	Mag.	No.	Mag.	No.	Mag.
1	5	3	5	5	5
2	5	4	5[1]	6	6[2]

[1] Mag. Hyde 6

[2] „ „ Lat. 6 Pers. 3 Sharpe Lat. 6 Pers. 6

Stellæ Libræ.

No.	Mag.	No.	Mag.	No.	Mag.
1	3–2	4	5-6	6	5–6
2	5–6	5	4	7	4
3	3–2			8	4

Extra hanc Figuram.

No.	Mag.	No.	Mag.	No.	Mag.
1	5	4	6	7	3–4
2	4–5	5	6	8	4
3	4–5	6	4	9	4

Stellæ Scorpionis.

No.	Mag.	No.	Mag.	No.	Mag.
1	3	8	2	15	4
2	3	9	3	16	3–4
3	3	10	5–6	17	3
4	3–4	11	5–6	18	3–4
5	4	12	3	19	3
6	4	13	3	20	3
7	3[1]	14	4	21	3–4

[1] Mag. Hyde 3-4

Extra hanc Figuram.

No.	Mag.	No.	Mag.	No.	Mag.
1	4-3[1]	2	5	3	5

[1] Mag. Hyde 4-5

Stellæ Sagittarii.

No.	Mag.	No.	Mag.	No.	Mag.
1	3-4	11	4-5[4]	22	3
2	3-2[1]	12	5-6	23	4-5[8]
3	3[2]	13	4-5	24	4-5[9]
4	3	14	4[5]	25	3-4[10]
5	4	15	6-7[6]	26	4-5[11]
6	3	16	5[7]	27	4-5[12]
7	4[3]	17	6	28	5
8	nebulosa	18	5-6	29	5
9	4	19	4-5	30	5
10	4	20	5-6	31	5
		21	4-3		

[1] Mag. Hyde 3
[2] „ „ 3-2
[3] „ „ 4-3
[4] „ „ 4
[5] Mag. Hyde 4-5
[6] „ „ 6 "obscura"
[7] „ „ 5-6
[8] „ „ 4
[9] Mag. Hyde 4
[10] „ „ 3
[11] „ „ 4
[12] „ „ 4

Stellæ Capricorni.

No.	Mag.	No.	Mag.	No.	Mag.
1	3-4	10	6	20	4
2	5-6	11	4	21	4
3	3-4	12	4	22	4-5
4	6-7	13	4-5	23	3 4
5	6	14	4-5	24	3
6	6	15	5-4	25	5-6
7	6	16	6	26	5
8	6	17	6	27	5
9	6	18	5-6	28	5
		19	4		

Stellæ Effusoris Aquæ.

No.	Mag.	No.	Mag.	No.	Mag.
1	6–7	15	4–5	29	4
2	3–4	16	4	30	5
3	5	17	6	31	5
4	3–4	18	4–3 [2]	32	5
5	5	19	4–5 [3]	33	5
6	6	20	6	34	5
7	3–4 [1]	21	5–6	35	5
8	4–3	22	5–6	36	4
9	3–4	23	4–5 [4]	37	4
10	4–3	24	4–5	38	4
11	3–4	25	4–5	39	4
12	3–4	26	4–5	40	4
13	4	27	4	41	4
14	5–6	28	4	42	1

[1] Mag. Hyde 5–6
[2] „ „ 3
[3] Mag. Hyde 4
[4] „ „ 4

Extra hanc Figuram.

No.	Mag.	No.	Mag.	No.	Mag.
1	4–3	2	4–3	3	4–3

Stellæ Piscis.

No.	Mag.	No.	Mag.	No.	Mag.
1	4	12	4	24	5
2	4–5	13	4	25	5
3	4–5	14	5 [1]	26	6–7 [5]
4	4	15	4 [2]	27	6–7 [6]
5	4	16	4–5 [3]	28	6–7 [7]
6	4	17	4	29	4
7	4	18	4	30	4
8	4	19	3–4 [4]	31	4
9	6	20	4	32	4
10	6	21	5–6	33	4
11	4	22	3–4	34	4
		23	5		

[1] Mag. Hyde 6
[2] „ „ 5
[3] Mag. Hyde 4
[4] „ „ 3
[5] „ „ 6 "minuta"
[6] Mag. Hyde 6 "minuta"
[7] „ „ 6 „

Extra hanc Figuram.

No.	Mag.	No.	Mag.	No.	Mag.
1	4	2	4	4	4
		3	4		

Stellæ Ceti.

No.	Mag.	No.	Mag.	No.	Mag.
1	4	8	4	16	3–4
2	3	9	4	17	6
3	3	10	4–3[1]	18	6
4	3–4	11	4–3	19	5–6
5	4	12	3–4	20	5–6[3]
6	4	13	4–5[2]	21	3–4
7	4–5	14	3–4	22	3–4[4]
		15	3–4		

[1] Mag. Hyde 4
[2] „ „ 4
[3] Mag. Hyde Lat. 5 Pers. 5–6
[4] „ „ 3–2

Stellæ Gigantis (*Orion*).

No.	Mag.	No.	Mag.	No.	Mag.
1	nebulosa	14	6	26	2
2	1	15	6	27	2
3	2	16	5	28	2
4	4[1]	17	4	29	3–4
5	4	18	4	30	4
6	6	19	4	31	3–4
7	5	20	4	32	3–4
8	5	21	4	33	4–5
9	6	22	3[3]	34	4–5
10	6	23	3[4]	35	1
11	5	24	3[5]	36	4–3
12	5[2]	25	4	37	4–3[6]
13	4			38	3–2[7]

[1] Mag. Hyde 4–5
[2] „ „ 5–6
[3] „ „ 3–4
[4] „ „ 3–4
[5] Mag. Hyde 3–4
[6] „ „ Lat. 4–3 Pers. 4
[7] „ „ „ 3 „ 3–2

Stellæ Fluminis (Eridanus).

No.	Mag.	No.	Mag.	No.	Mag.
1	4	12	4[3]	24	5[11]
2	4	13	5–4[4]	25	4
3	4–5	14	3–2[5]	26	4
4	4–5	15	5–6[6]	27	4
5	4	16	4[7]	28	4[12]
6	4–5[1]	17	4[8]	29	4
7	5–6	18	4	30	4–3
8	4	19	4[9]	31	omitted[13]
9	4	20	4[10]	32	4
10	3–4	21	4	33	4
11	3–4[2]	22	4	34	1
		23	4		

[1] Mag. Hyde 4
[2] ,, ,, 4
[3] ,, ,, 3–4
[4] ,, ,, 3–4
[5] ,, ,, 4
[6] ,, ,, 5
[7] ,, ,, 4–3
[8] Mag. Hyde 5–6
[9] ,, ,, 4–5
[10] ,, ,, Lat. 4 Pers. 4–3
,, Sharpe ,, 4–3 ,, 4–3
[11] ,, Hyde 5–6
[12] ,, ,, 4–5
[13] ,, ,, 4

Stellæ Leporis.

No.	Mag.	No.	Mag.	No.	Mag.
1	5	5	4–3	9	4–3
2	5	6	4–3	10	4–3
3	5	7	3–4	11	4–3
4	5	8	3–4	12	4[1]

[1] Mag. Hyde 4–3

Stellæ Canis Majoris.

No.	Mag.	No.	Mag.	No.	Mag.
1	1	7	5	13	5
2	4[1]	8	5	14	3
3	5	9	3	15	3
4	4	10	5	16	4
5	4	11	5	17	3
6	5	12	4	18	3[2]

[1] Mag. Hyde 4–5
[2] Mag. Hyde 3–4

Extra hanc Figuram.

No.	Mag.	No.	Mag.	No.	Mag.
1	4	5	5	8	4-5
2	4	6	4-5	9	3
3	5	7	4-5	10	omitted[2]
4	4-5[1]			11	4-5

[1] Mag. Hyde 4 | [2] Mag. Hyde 3

Stellæ Canis Minoris.

No.	Mag.	No.	Mag.
1	4	2	1

Stellæ Navis.

No.	Mag.	No.	Mag.	No.	Mag.
1	5	16	4	31	2
2	3	17	2	32	3
3	4-3	18	5	33	4-3
4	5	19	5	34	6
5	5-6	20	5	35	2
6	4-3	21	5	36	4
7	4	22	4	37	3
8	4	23	4	38	3
9	5	24	4	39	3
10	4-3[1]	25	4-3	40	4
11	5-6[2]	26	4-3	41	4-5[3]
12	3	27	4	42	4
13	5	28	4	43	3-4
14	5	29	4-5	44	1
15	4	30	4-5	45	3-4[4]

[1] Mag. Hyde 4-5
[2] „ „ Lat. 5 Pers. 5-6
[3] „ „ 4-3
[4] „ „ Lat. 3 Pers. 3-4

Stellæ Hydri.

No.	Mag.	No.	Mag.	No.	Mag.
1	4–5	9	4–5	18	3
2	4	10	4–5	19	4
3	4	11	6–7	20	4–3 [2]
4	5	12	2	21	4–3
5	4–3	13	4	22	4
6	6	14	4	23	3
7	1 [1]	15	4–3	24	3–4
8	4–5	16	3–4	25	3–4
		17	4–5		

[1] Mag. Hyde 4 — [2] Mag. Hyde 4

Extra hanc Figuram.

No.	Mag.	No.	Mag.
1	3	2	4

Stellæ Craterœ.

No.	Mag.	No.	Mag.	No.	Mag.
1	4	3	4	6	4–5
2	4	4	5	7	4–5
		5	4–5		

Stellæ Corvi.

No.	Mag.	No.	Mag.	No.	Mag.
1	3 [1]	3	5	6	3
2	3	4	3	7	omitted [2]
		5	3		

[1] Mag. Hyde 3–4 [2] Mag. Hyde 3

Stellæ Centauri.

No.	Mag.	No.	Mag.	No.	Mag.
1	5	13	4–3	26	3
2	5	14	4	27	5
3	4	15	4–3	28	5–6
4	5	16	3	29	3
5	3	17	4–3	30	omitted [1]
6	3	18	3	31	2
7	5	19	5	32	2
8	4–5	20	5	33	3–4
9	4	21	5	34	2
10	4	22	5	35	1
11	4	23	3	36	2–1
12	4–3	24	5	37	4–5
		25	5–4		

[1] "Ptolemæus dicit esse magnitudinis 3"

Stellæ Feræ (*Lupus*).

No.	Mag.	No.	Mag.	No.	Mag.
1	3	7	5	14	4
2	3	8	5	15	5-4[5]
3	4-3	9	4-3[1]	16	5[6]
4	3-4	10	5[2]	17	5[7]
5	4-3	11	4-5[3]	18	6
6	5	12	4[4]	19	5-6
		13	5		

[1] Mag. Hyde 5
[2] „ „ 4-5
[3] Mag. Hyde 5
[4] „ „ 4-5
[5] „ „ 5
[6] Mag. Hyde 5-4
[7] „ „ 5-6

Stellæ Thuribuli (*Ara*).

No.	Mag.	No.	Mag.	No.	Mag.
1	6	3	4-3	6	4
2	4	4	5-6	7	4
		5	4-5		

Stellæ Coronæ Australis.

No.	Mag.	No.	Mag.	No.	Mag.
1	4	5	5-6	10	6
2	6	6	5	11	5-6
3	6-5	7	5	12	5-6
4	5-6	8	5	13	5
		9	6		

Stellæ Piscis Australis.

No.	Mag.	No.	Mag.	No.	Mag.
1	4	5	5	8	5
2	4	6	6-7	9	4-3[1]
3	4	7	5	10	4
4	4			11	3-4

[1] Mag. Hyde 5-4

A Formula for reducing Precession in Right Ascension and Declination from Bessel's to Struve's Constants. By Professor Dr. A. Krueger, Director of the Observatory, Gotha.

Denoting by p_o and q_o the precession of a star in R.A. and Decl. computed with the constants of Bessel, viz.:

$$m = 46''.04370, \quad n = 20''.05960 \quad \text{for} \quad 1800$$
$$= 46''.07456, \quad = 20''.04990 \quad ,, \quad 1900$$

and by p, q the precessions of the same star according to Struve's constants, viz.:

$$m = 46''.06230, \quad n = 20''.06070 \quad \text{for} \quad 1800$$
$$= 46''.09079, \quad = 20''.05207 \quad ,, \quad 1900$$

the following formula will give the reduction from Bessel to Struve:

$$p - p_o = +0^s.001072 + 0^s.000054837\, p_o \quad \text{for} \quad 1800$$
$$= +0^s.000750 + 0^s.000108227\, p_o \quad ,, \quad 1900$$

$$q - q_o = +0^s.000054837\, q_o \quad \text{for} \quad 1800$$
$$= +0^s.000108227\, q_o \quad ,, \quad 1900$$

or,

		Factor.	Diff.
1800	$p - p_o = +0^s.00107 + 0^s.0005484\, p_o$	1 : 18236	1618
1810	$+0^s.00104 + 0^s.0006018\, p_o$	1 : 16618	1354
1820	$+0^s.00101 + 0^s.0006551\, p_o$	1 : 15264	1150
1830	$+0^s.00098 + 0^s.0007085\, p_o$	1 : 14114	789
1840	$+0^s.00094 + 0^s.00007619\, p_o$	1 : 13125	860
1850	$+0^s.00091 + 0^s.00008153\, p_o$	1 : 12265	754
1860	$+0^s.00088 + 0^s.00008687\, p_o$	1 : 11511	666
1870	$+0^s.00085 + 0^s.00009221\, p_o$	1 : 10845	594
1880	$+0^s.00081 + 0^s.00009755\, p_o$	1 : 10251	532
1890	$+0^s.00078 + 0^s.00010289\, p_o$	1 : 9719	479
1900	$+0^s.00075 + 0^s.00010823\, p_o$	1 : 9240	

For $q - q_o$ the precession q_o is to be corrected by the same factor.

Example: $\alpha = 2^h\ 0^m\ 0^s$ $\delta = +88°\ 0'$ for 1825; by direct computation.

$$p_o = +22^s\cdot2155, \quad q_o = +17\cdot3700 \quad \text{Bessel}$$
$$p = +22^s\cdot2180, \quad q = +17\cdot3712 \quad \text{Struve.}$$

By formula, the factor being 1 : 14656,

$$p - p_o = +0^s\cdot0010 + 0^s\cdot0025 = +0^s\cdot0035$$
$$q - q_o = +0\cdot0012$$

Gotha, 1879, *Feb.* 10.

Les longueurs du pendule à sécondes à Poulkova, à St.-Pétersbourg et aux différents points de la Russie occidentale, corrigées de l'influence produite par la flexion des supports du pendule construits par M. Repsold. Par M. A. Savitsch, Professeur d'Astronomie à l'Université de St.-Pétersbourg.*

(*Abstract.*)

The paper is a sequel to the author's Memoir presented to the Royal Astronomical Society in 1872, and printed in their *Memoirs*, vol. xxxix., pp. 19–29. By the aid of the researches of Peirce, Cellerier, and Plantamour in regard to the flexibility of the supports of the pendulums as constructed by M. Repsold, he is at present able to give the lengths of the seconds pendulum for different points of Western Russia with more precision than in his Memoir of 1872. The corrected results are :—

Station.	Latitude N.			Longitude E. of Greenwich.			Length of Seconds Pendulum in Paris lines.
	°	′	″	h	m	s	
Tornea	65	50	43	1	36	54	441·2460
Nicolaistadt	63	5	33	1	26	26	441·1228
St. Petersburg	59	56	30	2	1	14	441·0254
Revel	59	26	37	1	39	1	441·0125
Dorpat	58	22	47	1	46	54	440·9697
Jacobstadt	56	30	3	1	43	4	440·8835
Vilna	54	41	2	1	41	12	440·8288
Belin	52	2	22	1	40	52	440·7203
Krementz	50	6	8	1	42	54	440·6467
Kamenetz-Podolsk	48	4	39	1	46	18	440·5778
Kischeneb	47	1	30	1	55	18	440·5212
Ismail	45	20	34	1	55	16	440·4413

* The Memoir will be printed *in extenso* in the *Memoirs* of the Society.—Ed.

The author remarks that the reversible pendulum and its tripod, constructed by M. Repsold, are very convenient for transport and differential observations of the length of the seconds pendulum in different places; but, to obtain the correct length in any particular place, recourse must be had to a series of observations difficult to execute with precision. He suggests that the pendulum should be suspended at a given place, as well from its actual tripod as from a solid support fixed in a wall, as by Captain Kater and other English observers. The comparison of the time of oscillation for these two methods of suspension would be sufficient to determine the correction depending on the flexibility of the tripod.

The Memoir is dated January 11, 1879.

On a New Method of determining Astronomical Refractions.

By David Gill, Esq.

The law of astronomical refraction is by no means known with certainty. Bessel and Nyren have, it is true, arrived at very similar results on different hypotheses, but the state of our knowledge of refraction (especially beyond 80° zenith distance) is not satisfactory.

The ordinary well-known method of determining refraction is to observe the zenith distance of stars at their upper and lower culmination. Then, with an assumed latitude of the Observatory and an assumed law of refraction, to calculate the polar distances, and finally to find such a correction to the assumed latitude and assumed law of refraction as shall reduce the sum of the squares of the residuals to a minimum. The whole question then becomes a very involved one, for it includes, besides an imperfectly known law of refraction, all the unknown errors of division of the circle, the errors of flexure, &c., which are so difficult to determine completely.

I think, therefore, that a perfectly independent method of determining the absolute refraction at any altitude, and which is entirely independent of any assumed law, is not only a great desideratum in practical astronomy, but a subject of much interest as a physical research. I therefore lay the following proposal before the Society in its present form with the hope of benefiting, in the after practical application of the method, by the suggestions of the Fellows.

To fix our ideas:

1. Let us suppose an Observatory situated on the Earth's Equator.

2. Let this Observatory be provided with an instrument on

the principle of what is now commonly known as a Talcott's Zenith Telescope, and this telescope be provided with horizontal wires, over which the vertical transit of a star may be observed.

3. At such a station suppose two stars whose declination is 0°, and whose difference of right ascension is known. If vertical transits were observed with such an instrument at exactly equal zenith distances on opposite sides of the zenith, then the arithmetical sum of the hour angles will differ from the true difference of right ascension of the stars by twice the refraction.

4. The apparent altitude would be obtained directly from the apparent hour angle and the known declination and latitude of the place; hence we have directly what we want, viz. the true refraction for an apparent altitude.

It is quite true that the case I have supposed is the most favourable possible; but at Observatories of considerable latitude the method may still be employed with every prospect of success.

It is only necessary to select stars of such declination that they are on the prime vertical about the altitude at which we desire to investigate the refraction, and so observe the refraction in right ascension.

A small error in the declination of the star or latitude would then have no sensible effect in the result.

The conditions necessary to complete success appear to be:—

(*a*) A proper selection of stars *of uniform magnitude* which shall be on the E. and W. prime vertical in convenient pairs for the investigation of refraction at each required zenith distance, and so that there shall be a short convenient interval between the observation E. and W. at the same zenith distance.

(*b*) The rigid determination of the right ascensions of all these stars by the same observero makes the observations of vertical transits.

(*c*) The use of a reversing prism in front of the eyepiece, so that all the stars may be observed to pass through the field *apparently* in the same horizontal direction; or, better still, be observed over half the wires in one direction, and over the other half of the wires in the opposite direction.

(*d*) The construction of an equal-altitude instrument, capable of preserving the mutual rigidity of its parts for 20 minutes of time.*

(*e*) The accurate determination of the declinations of the stars. This could be done very rigidly by the method of Struve by observations in the prime vertical.

(*f*) The continuation of the observations for at least a year to eliminate the possible periodic errors of the right ascensions, and the employment of an underground clock in an airtight case.

(*g*) By confining the observation to 7th mag. stars, a sufficient selection would be obtainable, and at the same time the

* I shall present a description of such an instrument at a future Meeting.

errors due to personality in right ascension depending on magnitude would be avoided.

It is to be remarked that this method is most useful for low latitudes; but that is precisely where the greatest difficulties are encountered in the other method.

It is also to be remarked that the method is *entirely* free from systematic instrumental error.

On the Change in the Errors of Hansen's Lunar Tables between 1848 and 1876. By W. T. Lynn, B.A. (London).

In the *Monthly Notices* for 1860, June 8 (vol. xx., p. 320), the Astronomer Royal gave a series of comparisons of places of the Moon derived from Burckhardt's and from Hansen's Lunar Tables, with places obtained from the Greenwich observations made with both the Transit Circle and the Altazimuth instruments, for the years from 1847 to 1858. The result showed, as is well known, an immense superiority during that time of Hansen's over Burckhardt's Tables; but an impression has gained ground that the former have not in more recent years represented the Moon's place nearly so well as they did at that period. I have thought it worth while to calculate for one recent year the sums of the squares of the Moon's errors deduced from comparing the *Nautical Almanac* places (derived from Hansen's Tables) with those obtained from the Greenwich observations, and to compare them with those of one of the earlier years, the results of which were furnished by the Astronomer Royal. In doing so, I have selected the year 1876 as the last of which the Greenwich observations have been published, and compared its results with those of 1848, the earliest in which Altazimuth observations were made throughout the year. These years are separated by an interval of twenty-eight years, and the sums of the squares of the errors in longitude and ecliptic north polar distance are as follows :—

1. *From Observations with the Transit Circle.*

Year.	No. of Obs.	Sums of Squares of Errors of Longitude.	Sums of Squares of Errors of E.N.P.D.
		"	"
1848	113	1132·64	810·21
1876	82	8433·37	466·88

2. *From Observations with the Altazimuth.*

Year.	No. of Obs.	Sums of Squares of Errors of Longitude.	Sums of Squares of Errors of E.N.P.D.
		"	"
1848	199	2567·76	1989·89
1876	171	17605·94	1696·33

This comparison seems to show that, whilst the error of E.N.P.D. has not altered to the extent, at any rate, of being of a different order of magnitude (that it is somewhat smaller in 1876 being probably chiefly due to the smaller number of observations of that year), the error of longitude has, on the other hand, increased so much that the sum of the squares of the errors with each instrument was in 1876 about seven times as great as it was in 1848.

To determine whether the above increase in the sums of the squares of the errors in longitude is principally due to greater fluctuations in the error on different days, or to progressive change in the mean error for different years, I have calculated the value of the mean error for the above years, and for the year midway between them, i.e. 1862,* with the following result. (It is to be remarked that the errors of Hansen's Tables for 1848 are given, with those of later years for which the *Nautical Almanac* places were from Burckhardt's, at the end of the *Greenwich Observations* for 1859. All the errors are set down in the nature of excess of tabular over observed.)

1. *From Observations with the Transit Circle.*

Year.	No. of Obs.	Mean Error in Longitude for the Year.
		"
1848	113	+0·19
1862	85	−2·83
1876	82	+9·72

2. *From Observations with the Altazimuth.*

Year.	No. of Obs.	Mean Error in Longitude for th Year.
		"
1848	199	+1·90
1862	166	−3·55
1876	171	+9·31

These numbers indicate very clearly remarkable changes in the mean error in longitude of Hansen's Tables, which, almost insignificant at the commencement of the period here referred to, or about thirty years ago, first changed its sign (still continuing small) a few years afterwards, and subsequently to that again changed its sign and increased considerably in magnitude, to which increase that of the sums of the squares of the errors mentioned above is evidently principally due.

Some years ago, Professor Newcomb published, in the *American Journal of Science and Arts* (Number for September 1870, Second Series, vol l., p. 183), a paper entitled "Considerations on the

* 1862 is the first year in which the *Nautical Almanac* used Hansen's Tables.

Apparent Inequalities of Long Period in the Mean Motion of the Moon," in which he gives (page 191) a similar comparison of the mean errors of the longitude in different years, both from the Greenwich and Washington observations, but limiting the former (which terminate in 1868, whilst the Washington extend one year further) to those made on the meridian, or with the Transit Circle. In comparing this with the results above, it will be noticed that Professor Newcomb gives his errors in the nature of excess of observed over tabular place, or of apparent correction applicable to the tables. Within their respective limits our results are mutually to a great extent confirmatory. Professor Newcomb commences his comparison with the year 1850, in which the error in longitude, both from Greenwich and Washington observations, is very small. In 1862 the mean error from both Greenwich and Washington is about $-2\frac{1}{2}''$ for excess of tabular over observed place (as always set down in the *Greenwich Observations*). In 1868, the last year for which Professor Newcomb gives the Greenwich error (derived only from the observations of the principal observers), that and the Washington error are both about $+4\frac{1}{2}''$, whilst in 1869, for which he gives the mean error derived from the Washington observations only (those made at Greenwich being not accessible to him at the time of the publication of his paper), that error amounts to $5\frac{1}{2}''$. In 1876, as we have seen, the mean error deduced from the Greenwich observations was approaching $10''$, equivalent to two-thirds of a second of time.

I have had the curiosity to compute the mean error in longitude of Burckhardt's Tables for 1848. The Transit Circle observations, 113 in number, give $+7''{\cdot}87$; the Altazimuth, 199 in number, give $+8''{\cdot}68$. The sums of the squares are furnished in the Astronomer Royal's paper before referred to; they are, for the Transit Circle, 7662·82, and for the Altazimuth 18880·81. Hansen's Tables therefore do not appear to represent the Moon's place better in 1876 than Burckhardt's in 1848. The latter, it will be remembered, were published in 1812; and the author mentions in the preface that their superiority over those of Bürg (published in 1806) had been shown, in that a comparison of 167 observations made at Greenwich and Paris with places from his own Tables gave the sum of the squares of the errors in longitude only about two-thirds of that obtained from a similar comparison with places from Bürg's Tables, besides diminishing the sum of the squares of the errors in latitude.

Note on η Draconis. By W. T. Lynn, B.A. (London).

The *Nautical Almanac* star *η Draconis* appears in the Pulkowa *Catalogue de 514 Etoiles doubles et multiples* (published in 1843) as a double star, the components of which, at the distance of 4″, are stated to be of the 2·3 and 8th magnitude respectively.

The large star is contained (repeatedly observed) in all the great Greenwich Catalogues. A single observation of the small star is given in the First Seven-Year Catalogue for 1860 and the Second Seven-Year Catalogue for 1864. But in the first of those catalogues the small star appears to precede the large star by $0^s{\cdot}37$, and in the second to follow it by $0^s{\cdot}32$. Reference, however, to the original observation in the former (which observation was made on 1856, February 16) convinces me that a misunderstanding of its language was fallen into when the observations of that year were compared and reduced, and that the observation printed as referring to the large star really referred to the small one, and *vice versâ*. For the observer, Mr. Criswick, states that the small star was observed in transit over the five last wires and the large star over all the nine wires. Now the star observed over all the wires certainly precedes the other, but (apparently because the R.A., when reduced, of the second star, agrees better than that of the first with the other observations of the large star in that year) it was considered, when the results were put together at the end of the year, that the second star was the large *Nautical Almanac* star, and the star preceding it was the small companion star (which Struve, as above mentioned, calls of the 8th magnitude).

If then we transfer these observations accordingly, we shall find that the R.A. of the large star, from nine Greenwich Transit-Circle observations, is $16^h\ 22^m\ 2^s{\cdot}98$; that of the small star, from only one observation, $16^h\ 22^m\ 3^s{\cdot}17$; distance in R.A., $0^s{\cdot}19$. No N.P.D. of the small star was observed that year.

Combining this result with the other observations of the *Nautical Almanac* star in the First Seven-Year Catalogue, we shall find the R.A. in this Catalogue, for the epoch 1860, to be $16^h\ 22^m\ 6^s{\cdot}21$, instead of $16^h\ 21^m\ 6^s{\cdot}23$, as there printed. The R.A. of the small star will be $16^h\ 22^m\ 6^s{\cdot}36$, instead of $16^h\ 22^m\ 5^s{\cdot}86$. A further reduction in the R.A. of the *Nautical Almanac* star must be made, in consequence of the fact that an erroneous proper motion was used in determining its place in that Catalogue. The R.A. was not observed by Bradley, and the proper motion in the B.A.C. (used in the *Nautical Almanac* until 1873) was determined by a comparison of Piazzi's with later observations. This proper motion amounts to $+0^s{\cdot}023$; but being found to be too large, the *Nautical Almanac*, in 1874 and subsequent years, used $+0^s{\cdot}005$, determined by Mädler. Mr. Downing, in the *Monthly Notices* for last March, made a re-determination, and found it to be $+0^s{\cdot}004$. The *Greenwich Observations* alone would give even

less than that; and it seems at any rate clear that the proper motion in R.A. is practically insensible. The First Seven-Year Catalogue being reduced to the epoch of the last year (1860), of which the observations are included in it, makes the amount of proper motion used in the reductions of some importance. Assuming that for this star to be insensible, instead of $+0^s.023$ per year as actually used, we shall have the R.A. $0^s.05$ smaller; so that finally the R.A. of η^2 *Draconis* in that Catalogue should be $16^h\ 22^m\ 6^s.16$. It is to be presumed that the *Nautical Almanac*, in calling the star η^2 *Draconis*, considered Groombridge 2345, which precedes it by about 10^s and is of $11'$ less N.P.D., to be η^1 *Draconis*.

It will be seen that the small star, in the Second Seven-Year Catalogue (where it is numbered 1869), follows the *Nautical Almanac* star by $0^s.32$.

I may mention that my attention was directed to this star by a remark of Professor Bredichin in the fifth volume of the *Annales* of the Observatory of Moscow, that the *Nautical Almanac* R.A. of it, some years ago, was more than $0^s.3$ in error. I here give the comparison between the R.A. in the successive Greenwich great Catalogues and the *Nautical Almanac* R.A. for the same epochs, correcting that of the First Seven-Year Catalogue as above:—

Catalogue.	Epoch.	R.A. in Greenwich Cat. h m s	R.A. in *N.A.* h m s	Error of *N.A.* s
Twelve-Year Cat.	1840	16 21 50·23	16 21 50·09	−0·14
Ditto do.	1845	16 21 54·19	16 21 54·32	+0·13
Six-Year Cat.	1850	16 21 58·14	16 21 58·42	+0·28
First Seven-Year Cat.	1860	16 22 6·16	16 22 6·62	+0·46
Second Seven-Year Cat.	1864	16 22 9·25	16 22 9·91	+0·66
Nine-Year Cat.	1872	16 22 15·66	16 22 16·11	+0·45